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SUSTAINABLE GOAT BREEDING AND GOAT FARMING IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

European Regional Conference on Goats
7–13 April 2014

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FOREWORD

Goat breeding in Central and Eastern European countries traditionally had a major role to play in the agriculture sector, providing livelihoods for the rural population. As the structure of the sector is now changing, more focus is needed not only to avoid existing and potential problems, but also to take advantage of new opportunities.

Breeding, nutrition, environment and production systems, animal and human health, animal welfare and new assisted reproduction technologies all contribute to sustainable agriculture, which can help the region to adapt to the new challenges. These topics were discussed at the Workshop on Sustainable Goat Breeding and Goat Farming in the Central and Eastern European Countries, which was held in Debrecen, Hungary, from 7 to 13 April 2014 and contributed to the sharing and exchange of knowledge among 184 participants from 29 countries.

The year 2014 was the International Year of Family Farming. As goat breeding and production is a traditional part of family farming, at international year offered a great opportunity to support collaboration among international experts on spreading innovative approaches and evaluating current and past tendencies.

This publication provides a complete set of papers delivered during the workshop and a summary of a round table discussion conducted at the end of the workshop. I hope that the brochure we present to you today will contribute to a better understanding and appreciation of the goat production in the region.

Vladimir Rakhmanin

Assistant Director-General
Regional Representative for Europe and Central Asia

SUMMARY OF THE CONFERENCE AND THE FAO WORKSHOP

Main purpose

The aims of these scientific meetings were to evaluate the situation of goat breeding and farming in Central, Eastern and Southeastern European countries, and to increase the knowledge on sustainable goat breeding and goat farming, animal nutrition, environment protection and production systems, animal welfare, animal health and methods for improving reproduction, and the possible relationship between the consumption of goat products and human health.

Participants and papers

There were 184 participants from 29 countries: in Europe – Albania, Belarus, Croatia, the Czech Republic, France, Hungary, Italy, Latvia, Montenegro, Poland, Portugal, the Republic of Moldova, Romania, the Russian Federation, Serbia, Spain, The former Yugoslav Republic of Macedonia and Ukraine; from elsewhere in the region – Armenia and Georgia; and from other parts of the world – Egypt, Israel, Lebanon, Malaysia, , Mexico, Morocco, South Africa, Turkey and the United States of America.

There were 92 oral and 18 poster presentations introduced during the conference. Because of space limitations, only the papers from the Plenary Session and the FAO workshop (Session 1) are included in this book, along with selected papers from other sessions, the round table and the workshops on reproduction.

The programme

The Plenary Session addressed the main question of the conference and workshop: the environmental impact of goat farming and its integration into a sustainable system.

In Session 1: Breeding, which also served as a FAO Workshop on Protection of Local Breeds, other important questions were discussed: using local and indigenous goat breeds to protect and conserve the environment; adoption of "international" and "exotic" breeds (Alpine, Saanen, Nubian, Boer, etc.) and its effects on local populations; and effects of selection on the production ability of goats.

In Session 2: Nutrition, different levels of feed supply were discussed, including the impacts of extensive versus intensive feeding systems – challenges and opportunities.

Session 3: Environment and production systems, covered several subjects concerning goat keeping and farming in relation to the links between production and the environment: awareness of challenges for rural development, from lowland to upland (mountain); intensive versus extensive production systems (including technology); and ensuring the welfare of goats in intensive and extensive systems.

Session 4: Animal health, covered a very important topic: outbreaks of new diseases in

Europe. Viral and bacterial diseases of exotic origin (such as bluetongue virus, caprine arthritis encephalitis virus and Schmallenberg virus) and their effects on local goat populations were among the main subjects of discussion. Internal and external parasites, diagnoses and treatment were another focus of this session.

In Session 5: Human healths, two main groups of subjects were discussed: small scale/ on-farm versus industrial milk processing; and the use of quality assurance and Hazard Analysis Critical Control Point protocols to ensure product safety, and functional foods from goat milk and meat.

The aims of the Goat Welfare Round Table, which linked Sessions 3 and 4, were to develop a proposal for a new welfare assessment protocol for goats, concerning goat keeping in general. It also aimed to study welfare issues during transportation.

The Poster Session covered papers connected to the subjects of each session.

Goat reproduction issues were discussed at three workshops connected to Session 4. Workshop 1, summarized recent advances in reproduction management, from artificial insemination via embryo transfer to reproduction diseases. Workshop 2 discussed the possibilities for and results of non-hormonal modification of reproduction in goats. Workshop 3 summarized details of the latest results in reproduction management of intensive goat farming.

Agenda

The FAO Workshop on Goat Breeding was organized within the Hungarian–Romanian European Regional Cross-border Conference on Goats under the auspices of the International Goat Association in Debrecen (Hungary) and Oradea (Nagyvárad, Romania) between 8 and 11 April 2014.

Farms and goat breeds

On 7 April 2014, participants visited one of the biggest goat farms in Hungary, where 500 milking does belonging to different breeds (Alpine, Saanen, Hungarian Native and their crosses) and their progeny are kept along with 200 dairy cows (Holstein-Friesian). The milk produced is processed in the farm's own officially licensed dairy, and the several kinds of cheese and other products made are sold in various shops.

During the technical trip of the conference, on 8 April 2014, three goat farms with various herd sizes (of 35, 100 and 300 does, respectively) belonging to different breeds (local, exotic and their cross-breeds) were visited. Two of these farms had officially licensed dairies, in which various milk products were manufactured.

In addition, participants visited the Hortobágy National Park and its special collection of Hungarian ancient domesticated and indigenous breeds of various species (sheep, pig, poultry, goat, horse, cattle, pigeon, etc.). Special attention was given to Hungarian Grey cattle, Hungarian Racka sheep (both of which have unusual horns), native goats and Nónius horses.

On 8 April 2014, the Fourth Hungarian National Goat and Sheep Milk Products Competition was organized, and nearly 60 kinds of milk product were introduced and tasted.

After the conference, on 12 April 2014, participants visited a large Romanian goat farm (with 1 500 goats).

Scientific conference days

The Plenary Session, the FAO workshop (Session 1) and Session 2 were held in Debrecen on 9 April. Sessions 3 and 4, the round table and workshop 1 were held in Debrecen on 10 April.

Session 5 and workshops 2 and 3 were held in Oradea on 11 April.

Main conclusions

Reflecting the wide range of subjects discussed during the conference programme, the main conclusions of the conference also cover different fields of goat farming:

- In most of the countries goats are kept in small herds and the ratio of profitable specialized goat farms (with predominantly dairy herds) is low.

- Local indigenous goat breeds are less appreciated than they should be given their low profitability.

- Only a limited proportion of the goats kept are involved in nucleus breeding; the production ability of most goats is not known.

- To increase the profitability of goat farming, exotic goat breeds are imported into every country, where they are used mainly to improve milk production as well as to develop the ability of meat production.

- Exotic breeds are used in cross-breeding systems, but the use of pure-breeds is increasing rapidly.

- The nucleus breeding of goats is not very profitable, and the preservation and protection of local breeds cannot be carried out without significant monetary support from governments.

- Goat farmers should improve their feeding systems, as the level of nutrition is closely related to animals' production ability and profitability.

- Several feeding systems could be used, but the systems selected should follow the needs of the breeds and the demands of the people concerned, as well as the available feed resources.

- Numerous new diseases are appearing in Western Europe and some could reach Eastern Europe. It is, therefore, necessary to follow a strong animal health protection protocol when importing foreign livestock.

- Farms lose a significant ratio of their products because of internal and external parasites, but there are good methods for diagnosing and medicines for treating these pests.

- The environment has impacts on production systems, and goat farming is not an enemy of the environment. The production system used may be dangerous, but this is because of human rather than goat activity.

- Each environment supports certain types of production system, but for profitable goat farming (for milk production) only the intensive system is applicable.

- There are tools for estimating the nutrition status of goats and the values of available feeds in different environments (body condition score). These could be used to prevent the animals from becoming malnourished and to protect the environment from overgrazing.

- To ensure healthier animals and better production, animal welfare standards should be followed.

- Serious attention should be given to the reproduction traits of goats; several new methods can be used at the farm level (artificial insemination, embryo transfer, sperm freezing, oestrus synchronization, etc.), but hormonal treatment should not replace good management and feeding.

- Increased consumption of goat products could improve human health, but the production of basic materials and processed products should be controlled effectively.

- The milk and meat of goats can be used in functional foods, and are very good basic products for developing the functional values of foods for people.

Recommendations

Most Central, Eastern and Southeastern European countries need strong organizations of goat breeders and farmers to help individual farmers survive. Frequent regional meetings should be organized in this part of the world to discuss the latest results and develop useful cooperation.

The markets for goat milk products also need urgent help to reach the necessary level of development, and a market for goat meat should be created in this part of Europe.

Serious government support is needed in these countries to preserve and protect and to improve local indigenous goat breeds. Without adequate support, exotic breeds dominate goat farming and the old genetic values will slowly disappear.

Goat farmers need basic and further education to benefit from new information and developments that they can apply to their everyday management in order to build a sustainable and prosperous future.

Dr. Sándor Kukovics

Editor

ENVIRONMENTS AND GOATS AROUND THE WORLD: IMPORTANCE OF GENETIC AND MANAGEMENT FACTORS

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Abstract

Currently there are nearly 1 billion goats around the world. More than 90 percent are located in Asia and Africa and only 1.8 percent in Europe. Over the past 50 years, the goat population has multiplied 2.4 times, while other livestock species have maintained or decreased their populations. In developed countries, most goats are of high-yielding breeds, usually selected through programmes that require measurement of milk production, assessment of milk quality and evaluation of linear traits. In developing countries, goats are often kept to produce meat and, sometimes, also fibre. In arid areas, local goats are generally for only meat production because the nutritional requirements for milk production cannot be met in such extreme environments. However, in some areas with limited and seasonal sources of nutrients, it is possible for farmers to manage dairy goats. In these situations, technicians and farmers often make the mistake of introducing high-yielding breeds (Anglo Nubian, Saanen, etc.) without modifying them to local environmental conditions. The F1 cross-breed between local and foreign goats has had moderate success, but the final result produces an unpredictable genetic mixture, which is usually less rustic and less resistant to diseases, making it less productive.

Goats of local breeds are usually good walkers and can cover wide areas of grassland. Exotic and high-yielding goats graze near their pens, leading to grassland degradation and increasingly unsustainable systems. As a result, many people, including politicians, civil servants and biologists, consider goats to be responsible for environmental degradation. However, recent research has demonstrated that correct management of goats on grasslands helps to increase plant biomass and biodiversity.

Key words: goat, breed, census, milking

Importance of goats

Worldwide, there are nearly 1 billion goats (996 120 851 according to FAOSTAT, 2013) – more than the global pig population and 15 percent less than the sheep population. More than 90 percent of these goats are located in Asia and Africa, with only 1.8 percent in Europe, where Greece and Spain are the countries with the most heads. Over the past 50 years, the goat population has multiplied 2.4 times while other livestock species have maintained or decreased their populations. Milk production from goats (17 846 118 tonnes) has increased at a similar rate according to FAO statistics. About 45 percent of the world's goats are located in four countries: Bangladesh, China, India and Pakistan. With the exception of Pakistan, milk production in these countries has increased more rapidly than the goat population, reflecting a growing trend for rearing dairy goats.

FAO estimates that global production of goat meat is more than 5 million tonnes, representing an increase of 36 percent since 2000. According to FAOSTAT 2013, most of this meat is produced in Asia and Africa, which together account for 93.6 percent of the world's goat population and 94.5 percent of meat production. Bangladesh, China, India and Pakistan are the leaders in both meat and milk production. Meat production in Europe is much lower, with the largest quantity coming from Greece. Among European countries, France has the fourth largest goat population, but produces the largest amount of milk. It is well known that France has high-yielding dairy goats and produces large quantities of cheese, but it is surprising that French meat production also seems to be high, exceeding that of Spain, despite having only half as many goats (FAOSTAT, 2013). Among Eastern European countries, after the Russian Federation, Romania has the highest goat population, followed by Ukraine and Bulgaria. Again, FAOSTAT data are incomplete and unclear. Hungary produces more milk and about as much meat as Lithuania although its goat population is only 53 percent of Lithuania's. Information for both countries is given in round numbers (FAOSTAT, 2013).

Goat breeds

The main products from goats are meat, milk and fibre. Boer is the most popular meat breed, while Angora and Cashmere are the main fibre-producing breeds. A few dairy breeds, such as Saanen, Toggenburg, Alpine and Anglo-Nubian, are widespread and are frequently found in commercial herds throughout the world (Oklahoma University, 2014). However, dairy breeds require higher levels of care. The Saanen, Alpine and Toggenburg breeds were originally from the Swiss and French Alps, while Anglo-Nubians were developed in the United Kingdom of Great Britain and Northern Ireland by crossing British goats with bucks of African and Indian origin (Oklahoma University, 2014). In developed countries, goats belonging to these breeds are often seen in shows, usually under selection programmes that require measurement of milk production, estimation of milk quality and evaluation of linear traits (ADGA, 2014).

In developed countries, many dairy goats breeds have been selected to varying degrees. For example, the Girgentana breed originated in Malta, but currently its largest population is in Italy (Blundell, 1995). When Malta fever was detected, the Maltese Government promoted the substitution of goats with cows, resulting in a dramatic decrease in the Girgentana population. High-yielding dairy goat breeds in Spain include the Murciana-Granadina, the Malagueña and the Florida Sevillana in the arid south of the country. These are not seasonal goats and do not have important milk production and quality. Overall, there are 22 goat breeds in Spain, but most are in danger of extinction (Esteban, 2008). On the Canary Islands, three goat breeds (Amills et al., 2004) produce about 15 million kg of cheese per year. These goats have a rustic conformation but they are also high-yielding dairy breeds. The Majorera breed is widely distributed in Venezuela and Cabo Verde (Capote et al., 2004). In northern Senegal, Majorera goats can live in temperatures of up to 48 ºC, retaining good reproductive and productive performances.

All of these breeds are in developed countries and their nutritional requirements are usually satisfied by grass, forage and local and/or imported concentrates. However, the majority of the world's goats are in developing areas, and 60 percent are located in low-income food-deficit countries (FAOSTAT, 2013). In these environments, depending on other factors, there are dairy goats (not high-yielding), meat goats and sometimes goats that are milked only occasionally, such as in Senegal where goats are milked only when cows are dry.

Goats in arid areas

Many goats (dairy and other) are reared in arid areas. In these systems, most herds are of hardy indigenous breeds, adapted to grazing in degraded environments. Degradation in arid areas is currently an important and dangerous global problem. Dry areas cover 3 600 x 106 ha and affect 1 000 x 106 humans. Each day, 180 km2 of tropical forest and 110 km2 of cropland are lost; 33 percent of the earth's surface is in danger of degradation and US$42 billion is lost each year through desertification (Sánchez and Diaz, 2007; Suarez, 2007). In these areas, goats are usually reared for meat, but is it also possible for farmers to manage dairy goats in arid areas? When farmers have financial support they can reproduce the goats' natural environmental conditions and anything is possible, but it is less clear that dairy goats can be managed in arid areas using only the available resources.

There is general agreement that the main problem is a lack of food; either farmers have an alternative source that provides sufficient food (by-products, scrubland, etc.), or they are unable to satisfy the nutritional requirements for milk production. In either case, an additional problem is selecting the best goat breed for each management system. When farmers have an alternative source of food, they can select local genotypes or high-yielding goat breeds (Morand-Fehr, 1997); in either case, additional limiting factors have to be considered. While local genotypes are already adapted to local conditions, they are likely to be genetically limited as dairy goats. High-yielding goats guarantee good milk production, but will probably have problems adapting to local climate conditions (Lu and Akinsoyinu, 1990) and continuing to reproduce (Foote, 1990). Some farmers and technicians have explored potential solutions through crossing local with high-yielding breeds, but with mixed results (Pinto et al., 1992; Costa et al., 2007). When farmers use high-yielding breeds from a geographically similar zone, traits from local breeds have been successfully absorbed. Examples include Majorera goats from the Canary Islands adapting to the hot climate of Venezuela (Dickson et al., 1991; Capote et al., 2004) and Saanen goats in Mexico, although in this latter case a negative genetic trend has been detected, probably resulting from ineffective selection (Valencia, Dobler and Montaldo, 2005). When farmers are unable to satisfy the nutritional requirements for milk production, the use of high-yielding goats or cross-breeds becomes unsuitable (Capote, 2002).

An experience from Chile provides a useful example. In arid areas of the low Andes, the Government introduced Anglo-Nubian goats about 35 years ago. As this breed originated in African arid areas, the animals were expected to adapt successfully. However, Anglo-Nubians are also well adapted to wet climates in the United Kingdom of Great Britain and Northern Ireland, the United States of America and New Zealand. An F1 cross-breed between Anglo-Nubian and local Chilean goats had moderate success, but when local breeds were crossed and re-crossed, they disappeared and milk yields decreased dramatically. While the local breeds were good walkers and could cover wide grassland areas, the Anglo-Nubian goats grazed near their pens and the grasslands became increasingly degraded (Capote, 2002; Capote et al., 2004). This kind of adaptation problem is probably related to decreased parasite resistance in the new cross-bred population compared with the original local goats. It is well known that goat breeds can be trypanotolerant or trypanosusceptible, and Geerts et al. (2008) explain how goats in sub-Saharan countries lost their trypanotolerance through the introgression of trypanosusceptible genes in their populations. Gonzales et al. (2008) found differences in the resistance to parasites of hair and wool sheep, with hair sheep being more resistant.

It is also well known that the most widespread goat breeds are seasonal, while most of the local genotypes in hot climates are not seasonal (Foote, 1990). This problem often forces goat farmers to change their herd management and/or use drugs to increase pregnancy rates.

Goat morphology and management

An additional problem can occur with goats' udder skin. High-yielding breeds often have weak udders that are unsuitable for harsh environments (Ficken, Andrews and Engeltes, 1983; Gutiérrez et al., 2000). In the Canary Islands, this problem occurred when Saanen goats were introduced; later, they were removed (Capote et al., 1992). As already mentioned, local goats in arid areas are usually used for meat production only, because the nutritional requirements for milk production cannot be met in such extreme environments (Capote, 2002). However, in other areas with limited and seasonal sources of nutrients, farmers can manage dairy goats. These cases require the strategic management of milking. Frequency of milking is an important parameter in goat management: some breeds are milked twice a day in wet areas, while others are milked once a day in arid areas (Capote et al., 2008; Torres et al., 2013). This difference is probably because of the distances that herders in arid areas have to travel to find adequate grass, making it impossible to collect the goats for milking twice daily in the same place. Twice daily milking also requires more time, for both milk collection and processing into cheese. In hot climates, it is also impossible to maintain sanitary conditions for many hours without refrigeration.

In developed countries, based on data for the period until 1998, the differences in milk yields resulting from milking frequency were 26–45 percent (Mocquot et al., 1974; Mocquot and Guillimin, 1975; Mocquot, Guillimin and Tanguy, 1978; Wilde and Knight, 1990). Later research found differences of 6–18 percent in goats of Spanish breeds (Capote et al., 2006; Salama et al., 2004). The differences among Spanish, Alpine and United Kingdom goats were probably because the Spanish breeds have higher udder volumes, particularly in the Canary Islands (Knight, 1996). Goats have a milk autocrine feedback regulator of secretion that reaches the secretory cells later in animals with larger udders, because the milk takes longer to drop into the cistern (Wilde et al., 1995).

In arid areas, it is therefore useful to rear goats with high udder volume, as this has been shown to reduce production losses resulting from less frequent milking. Udder conformation is linked to goat morphology. In the United States of America and other countries there is a tendency to select "uphill" goats (ADGA, 2014), which are higher at the withers than the rump. Rustic goats usually show the opposite trend, with higher rumps (Capote et al., 1998) enabling them to move easily in steep and hard environments. "Uphill" selection leads to the udder dropping toward the ground. As milk production is correlated with udder volume, farmers who milk once daily need goats with bigger cisterns.

To conclude, goats are the most widespread livestock and a recent census confirms that their numbers and presence have increased in the poorest countries. Around the world, policies and projects that focus on goats have often suffered from unsuccessful development; more international exchange of knowledge is therefore necessary.

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SUSTAINABLE GOAT FARMING IN CENTRAL AND EASTERN EUROPE AND HUNGARY

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Abstract

The goat population of Central and Eastern Europe is only about 8–10 percent of the sheep population, while the number of goat farms is similar to that of sheep farms. To evaluate the potential sustainability of goat farming and breeding in the region a survey was developed and circulated among countries: Albania, Armenia, Belarus, Bulgaria, Croatia, Czech Republic, Georgia, Greece, Hungary, Montenegro, the Republic of Moldova, Romania, the Russian Federation, Serbia, Slovakia, Slovenia, The former Yugoslav Republic of Macedonia and Ukraine.

The information gathered and processed comprised numbers of goats; numbers of goat farms; shares of hobby, part-time and full-time farms; numbers of breeds (native and exotic); ages of does; production levels (milk, meat and reproduction); durations of lactation; sizes of herds on farms; land available to farmers; ratios and origins of rented land; education levels of farmers; labour used on farms; ages of goat farmers; production systems (traditional, semi-intensive, intensive); destinations of production (self-consumption or various markets); milking methods; milk processing (on-farm and/

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7 Faculty of Agriculture, University of Plovdiv, Bulgaria
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9 Institute of Animal Science, Prague
10 Hellenic Agricultural Organisation, DEMETER, Veterinary Research Institute, Thessaloniki, Greece
11 Faculty of Natural and Agricultural Sciences, Ovidius University, Constanta, Romania
12 Faculty of Agriculture, Novi Sad, Serbia
13 Slovak University of Agriculture, Nitra, Slovakia
14 Slovak Chamber of Agriculture and Food, Bratislava, Slovakia
15 Faculty of Agriculture, University of Ljubjana, Slovenia
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or by purchasing companies); shares of on-farm processing; annual quantities of milk processed on farms and in professional dairies; numbers of processing dairies and their availability to goat farms; prices of farm products (raw milk, live kids for slaughter, kid meat, cheese); markets for milk products and kids; ages and body weights of kids at sale; subsidies for goat farming; and the profitability of goat farming.

The most important findings were as follows: apart from in Romania, goat populations are declining; several native breeds are bred in the survey countries, but popular exotic breeds (such as Alpine, Saanen, Nubian and Boer) can be found in every country; 5–10 percent of does belong to nucleus herds and take part in performance testing, but 75–90 percent of goats are not registered; only limited areas of land are available; goat farmers have rather low levels of education; and profitability is highly dependent on the production intensity and size of the farm.

Introduction

Goat farming and breeding and goat milk and meat production have been practised in Central, Eastern and Southeastern Europe for thousands of years. Over the last two decades, the entire economies of many of these countries have been totally reorganized, and only limited information on the current state of goat farming is available. The 2014 European Regional Conference on Goats provided a good opportunity for collecting information on the situation of goat farming in 18 countries of Central and Eastern Europe.

Material and methods

To collect a wide range of information and data on goat farming in Central, Eastern and Southeastern European countries, a survey was developed and circulated among experts in each country.

The following information was requested and processed: numbers of goats; numbers of goat farms; shares of hobby, part-time and full-time farms; numbers of breeds (native and exotic); ages of does; production levels (milk, meat and reproduction); durations of lactation; sizes of herds on farms; land available to farmers; ratios and origins of rented land; education levels of farmers; labour used on farms; ages of goat farmers; production systems (traditional, semi-intensive, intensive); destinations of production (self-consumption or various markets); milking methods; milk processing (on-farm and/or by purchasing companies); shares of on-farm processing; annual quantities of milk processed on farms and in professional dairies; numbers of processing dairies and their availability to goat farms; prices of farm products (raw milk, live kids for slaughter, kid meat, cheese); markets for milk products and kids; ages and body weights of kids at sale; subsidies for goat farming; and the profitability of goat farming.

The countries that took part in data collection were Albania, Armenia, Belarus, Bulgaria, the Czech Republic, Croatia, Georgia, Greece, Hungary, Montenegro, the Republic of Moldova, Romania, the Russian Federation, Serbia, Slovakia, Slovenia, The former Yugoslav Republic of Macedonia and Ukraine. Data were collected from one organization per country, except for Hungary, where three organizations were used: the Central Office of Statistics (Hungary-KSH); the Hungarian Sheep and Goat Breeders’ Association (Hungary-MJKSZ); and the Hungarian Sheep and Goat Dairying Public Utility Association (Hungary-MJKKHE).

The collected data were processed and evaluated using Microsoft SPSS for Windows 10.0 software.

Results and discussions

Numbers of goats kept

The number of goats kept in each country varied widely (Table 1), being low in most countries, but much higher in those with mountainous or hilly regions. Greece alone had almost as many goats (4.8 million heads) as the Russian Federation (2.1 million), Romania (1.6 million), Albania (800 000) and Ukraine (660 000) combined. Only two other countries had more than 200 000 goats – Bulgaria with 293 000 and Serbia with

225 000 – while the Republic of Moldova had 120 000. All the others had fewer than

100 000 heads of goats. Some countries lacked accurate data on goats: in the Czech Republic only nucleus herds were registered and evaluated, while numbers from Georgia were estimates. In several countries (such as Belarus, Georgia, the Republic of Moldova and the Russian Federation) the number of goat farms was not known.

The sizes of goat farms/herds were also generally rather low. Herds of fewer than ten heads dominated in several countries: Montenegro (80 percent), the Czech Republic (76.7 percent), Slovakia (70.9 percent), Bulgaria (66.8 percent), as well as Greece and Slovenia (60 percent each). According to official data, more than 91 percent of goat farms in Hungary had fewer than ten heads. Other categories of farm size dominated in Albania, where 39.2 percent of herds had 10–30 heads; Armenia, with 35 percent of farms in the 100–200-heads category; and Georgia, where 60 percent of known goat farms had 50–100 animals. In Serbia, 40 percent of goat farms had 50–100 heads. In Belarus, most goats (98 percent) were kept in backyards, with about 24 smallholder farms known to have a total of 1 300 heads (2 percent). The numbers and shares of professional and industrial producers were somewhat low throughout the region. Very low shares of farms had 500–1 000 animals, and only a couple had more than 1 000.

In the Russian Federation, 10 percent of goats were kept by agricultural enterprises, with the remaining 90 percent owned by private (household) farms. In Ukraine, of the 664 800 goats kept, 659 400 were in household farms (99 percent) and 5 400 (1 percent) in agricultural enterprises. Two breeding farms in Ukraine kept 300 female goats each, and another two farms bred of 700; other types of farm had only a couple of goats each. In Montenegro, the total number of goats in 2014 was about 35 000; in 2012, 402 herds raised more than ten animals each, with a total of 18 538 heads (averaging 46 per farm).

Breeds and breeding: towards the Holstein Friesian effect

Local/indigenous breeds dominated in all the countries in terms of both numbers and shares, but these figures included animals that were developed by crossing local goats with exotic breeds (Table 2). While the numbers and shares of exotic (mainly dairy) goats could be considered negligible, their effects on cross-breeding have been rapidly increasing over the last decade, particularly in the past couple of years.

The number of exotic breeds (such as Alpine, Saanen, Nubian and Toggenburg breeds) has also been increasing, with most coming from France and some animals being imported from Germany, Italy, the Netherlands, Switzerland or the United States of America. A trend for importing and using meat (Boer) goats started in the second half of the 1990s, but has declined since because of low profitability. Hair (angora and mohair) goats also increased in numbers in the mid-1990's, when many people thought they would be the breeds for the future, but this trend has passed and only limited numbers of these animals remain in Eastern and Central Europe.

Among exotic imported dairy breeds, the French Alpine and Saanen dominated; almost all the countries were using these breeds in cross-breeding to improve the milking ability of local goat breeds. Local versions of these breeds were developed in the Czech Republic and Slovakia, or nationalized, as in Slovenia with the Slovenian Alpine and Saanen breeds. In other countries, these exotic breeds were bred under their original names. As the popularity of Alpine and Saanen breeds is increasing, the effect on goats could be similar to the effect of Holstein Friesian on dairy cattle, with dairy goats becoming increasingly similar to these exotic breeds, while the genetic background of the original local breeds is slowly destroyed.

In all the studied countries, less than 10 percent of the total goat population was in nucleus herds; generally, the figure was between 3 and 5 percent. More than 50 percent of exotic animals (Alpine, Saanen, Nubian, Boer, Toggenburg, etc.) were in nucleus herds in most countries.

The number of local breeds varied from country to country, with more than 11 in Albania, for instance, and only one in some west Balkan countries. There was one native meat breed in Slovenia, and some native hair (mohair and cashmere) breeds in the Russian Federation.

Milk production levels

Average milk production was much lower from local breeds than imported exotic breeds (Table 3). The difference was sometimes more than double. The Czech Republic, Slovakia and – to a degree – Slovenia were exceptional cases as the Alpine and Saanen breeds have been nationalized in these countries (as the White Shorthair, the Brown Shorthair, or the Slovenian Alpine or Saanen). Milking periods (number of milking days) were generally short, but tended to increase as the share of exotic breeds increased through cross-breeding. Most pure-bred exotic breeds had 250–300 days of milking, and sometimes more than 300 days. The milking seasons of local breeds were 80–120 days shorter.

Ages of does

The age distribution of does provides a very good picture of the state of the goat sector and the level of replacement, which is a tool for increasing the productivity and quality values of a herd. When less than 20 percent of the does are under two years of age, it could mean that replacements cover only losses of adult does and necessary selection. When the share exceeds 30 percent, the herd could be newly started. When more than 25 percent of does are over six years of age, the herd is becoming too old and needs significant young female replacements to survive.

In the studied countries, the goat populations of Georgia and Slovenia are increasing intensively. The age distribution in Greece is almost optimal, and those of Albania, Croatia, Hungary and Slovakia are well balanced. The breeding programme in Armenia started only two years before data collection so the population were still young. In Serbia, 65 percent of does were over four years, meaning that a higher ratio of replacement is required.

On average, the breeding doe populations of the studied countries could be described as well balanced in terms of age. However, data from most countries covered only registered breeding stock.

Farming systems

Depending mainly on the number of animals kept, farms can be operated full-time, part-time or as a hobby. Full-time farms dominated in Albania (98.58 percent), Armenia (92 percent), Greece (85 percent) and Georgia (60 percent). In Croatia (37 percent), Hungary (35 percent) and Serbia (20 percent) the shares of full-time farms were much lower. Part-time farms accounted for the largest shares in Serbia (60 percent), Croatia (48 percent) and Hungary (40 percent). Hobby farms had their largest shares in Georgia (30 percent), Hungary (25 percent) and Serbia (20 percent). The distribution in other countries was not clear.

Connected to the number of animals kept, the purpose of keeping goats varied little from country to country. In Albania, 98.4 percent of goat farms were operating as dual-purpose (milk and meat) activities, and only 1.6 percent produced hair. In Armenia and Serbia, goats were kept only for milk (100 percent). This purpose also dominated in Greece (98 percent), Slovakia (96 percent), Hungary (90 percent) and Croatia (68 percent). In the Czech Republic, 313 dairy goat farms were registered, along with 14 meat and 3 hair farms. Meat was the dominant purpose in Georgia (70 percent) and Slovenia (81 percent), and was limited in Hungary (10 percent).

Very few farms produced hair (mohair or cashmere) in Romania and Slovakia. This activity was introduced in the late 1980s and early 1990s, when a good number of exotic breeds were imported, but it had almost disappeared by 2014.

Production and milking systems

The largest shares of goat farms were operated under extensive traditional production systems in most of the countries (Table 5): Georgia (100 percent); Ukraine (99.2 percent); Belarus (98 percent); the Republic of Moldova (94 percent); the Russian Federation (90.1 percent); Serbia (85 percent); The former Yugoslav Republic of Macedonia (80 percent); Hungary (75 percent); Romania (77 percent); Bulgaria (70 percent); and Montenegro (50 percent). In some countries, an improved system was used in which animals received significant shares of supplementary feed as well as grazing: Slovenia (90 percent); Greece (85 percent); Slovakia (70 percent); Albania (63.8 percent); and Montenegro (40 percent). Intensive indoor goat keeping dominated in Croatia (60 percent) and was important in Greece and Montenegro (10 percent each) and in Hungary.

Traditional hand-milking still dominated in most of the studied countries: Georgia (100 percent); Ukraine (99.2 percent); Albania (98.8 percent); The former Yugoslav Republic of Macedonia (98.5 percent); Belarus (98 percent); the Republic of Moldova (94 percent); the Russian Federation (90.1 percent); Montenegro and Romania (80 percent each); Serbia and Greece (70 percent each); and Slovakia (64 percent). Simple milking machines (mainly bucket milking in stalls) dominated in Croatia (80 percent) and Hungary (70 percent), and had an important role in Slovakia (34 percent), Serbia (25 percent), Greece and Bulgaria (20 percent each), and Romania and Montenegro (15 percent each). Up-to-date milking parlours dominated in Slovenia (97 percent), and also played important roles in Hungary (20 percent) and Bulgaria, Croatia and Greece (10 percent each).

Milk production

The quantity of milk produced by each goat farm is highly dependent on the number of goats kept and milked and the breeds of those goats (Table 6). According to the Hungarian data, most farms produced less than 5 000 litres annually, as the average number of does was quite low. A similar but much lower dominance was found in Albania (68.4 percent). In Georgia, 100 percent of farms produced 5 000–10 000 litres of milk per year; 70 percent of the Armenian farms were also in this category, as were significant shares of farms in Slovenia (30 percent), Albania (22.6 percent), Croatia (21 percent) and Serbia (20 percent). In Greece, half of the farms produced 10 000–30 000 litres of milk annually, and high shares of farms were listed in this category in Slovenia (38 percent), Serbia (30 percent), Croatia (30 percent) and Armenia (20 percent). The category of 30 000–50 000 litres had a significant role only in Croatia (25 percent), Serbia (20 percent) and Greece (15 percent). Larger dairy goat farms in Serbia (30 percent) had milk yields of 50 000–100 000 litres annually, and 15 percent of the Greek goat farms were also in this category. Some farms produced 300 000–500 000 litres of milk in Croatia (2.0 percent) and Hungary (0.02 percent).

Purchase prices of raw milk and selling prices of milk products

Raw milk prices varied among countries (Table 7). In Armenia, Bulgaria, Croatia and Georgia, 100 percent of the milk sold received a price of €0.3–0.4/litre. About 70 percent of the Romanian milk was sold at this price, but 15 percent received less than €0.3/litre. In Serbia, the purchase price was €0.4–0.5/litre (100 percent). This price category also dominated in Albania (83.5 percent), and 35 percent of Hungarian and 10 percent of Romanian milk was also bought at this price. In Greece, the raw milk price of €0.5–0.6/litre dominated, and a large share of Hungarian milk (40 percent) was sold at this price. In Slovakia, 90 percent of milk sold at more than €0.6/litre. In Slovenia, the purchase price was €0.7–0.8/litre, but the highest price was in the Czech Republic, where raw milk sold at €1.3/litre in bio/eco shops.

The selling prices of goat milk products (mainly cheeses) also showed differences among countries. In four countries, 100 percent of goat milk cheese was sold at less than €6/kg (Albania, Armenia, Bulgaria and Georgia). Selling prices of €6–10/kg dominated in Greece and Serbia (100 percent each), Slovakia (80 percent) and Hungary (40 percent). In the Czech Republic, goat cheese prices were €10–20/kg (100 percent). Some 85 percent of the cheese in Croatia and 35 percent in Hungary were also sold at this price. Slovenia was a special case, with fresh cheeses selling at €11/kg and mature cheeses at €19/kg. Some special quality cheeses had prices of more than €20/kg in Slovakia (10 percent) and Croatia and Hungary (5 percent each).

Weaning and selling of kids

Weaning of kids at one day of age was practised in several countries (Table 8), but only in Serbia did it dominate (50 percent), as the artificial rearing of kids on larger farms is a common practice there. Kids weaned at one week of age in Croatia (10 percent) and Hungary (50 percent) also needed artificial rearing. A weaning age of one month dominated in Slovakia and Georgia (80 percent each), and this system was also used in Croatia (41 percent), Slovenia (30 percent); Hungary and Serbia (20 percent each). Two months was the dominant weaning age in Armenia and Greece (80 percent each), Slovenia (68 percent) and Hungary (60 percent), and had a significant role in Croatia (35 percent), Serbia (30 percent), Albania (21.5 percent), and Georgia and Slovakia (20 percent each). Most kids were weaned at more than two months of age in Albania (78.5 percent) and Bulgaria (80 percent), and this category also had a significant role in Armenia (20 percent), Greece (20 percent) and Hungary (10 percent).

For slaughter purposes, the kids were sold in four weight categories. The category of 8–12 kg live weight is sought after in only certain markets, such as Hungary (30 percent), Albania (21.5 percent) and Slovakia (20 percent). Live weights of 12–16 kg were preferred in Greece (80 percent), Albania (73.5 percent), Slovakia (70 percent), Hungary (60 percent), Serbia (50 percent), Bulgaria (35 percent) and Slovenia (30 percent). The 16–20 kg category was most popular in Georgia (70 percent), Croatia (62 percent) and Serbia (50 percent), and had significant shares in Bulgaria (35 percent) and Slovenia (30 percent). Live weights of more than 20 kg were preferred in Armenia (80 percent) and Slovenia (70 percent), and a high share of kids sold in Serbia (35 percent) was also in this category.

Kids sold at the cheapest prices (less than €2/kg) in Slovakia (70 percent), and the highest prices (€8–10/kg) in Albania (100 percent). In most countries, the dominant price category was €2–3/kg live weight: Bulgaria, Hungary and Serbia (100 percent each); Greece (95 percent); Georgia (90 percent); and the Czech Republic (60 percent). In Armenia, all kids (100 percent) sold at €3–5/kg live weight. This category also dominated in Croatia (70 percent), and accounted for a significant share of kids in the Czech Republic (40 percent). In Slovenia, kids generally sold at €4/kg live weight.

The destinations for goat farm products

Goat farm products tend not to have well-organized markets in any of the countries studied (Table 9). This is especially true of kids for slaughter and non-breeding adult stock goats. Goat meat was generally consumed at the farm level in Slovakia and Georgia (80 percent each), Hungary (69 percent), Armenia (50 percent) and Romania (40 percent). In other countries, this category accounted for a far smaller share. Local sales via informal relationships played a dominant role in Serbia (100 percent), Bulgaria (85 percent), Croatia (75 percent) and Slovenia (50 percent), and significant roles in Albania (34.4 percent), Romania and Armenia (30 percent each) and Hungary (29 percent). In Albania the largest share of kids/goats for slaughter was sold to local shops (43.8 percent), and this category also played an important role in Greece (30 percent), Armenia (28 percent) and Slovenia (20 percent). In Greece, direct selling for slaughter was the dominant market for slaughter kids and goats (62 percent); this category was also important in Slovenia (29 percent), but its shares in other countries were low. In some countries, small percentages of goats had unidentified destinations, which included sales of very young kids to zoos as feed for predators.

The situation was much clearer for the destinations of goat milk and milk products, but quite large differences could still be found among countries. On-farm consumption accounted for a dominant share in Georgia (80 percent) and Slovakia (60 percent), and was very important in Romania (40 percent) and Hungary (30 percent). Sales of milk and milk products via informal relationships were present in every studied country, but this category played a dominant role only in Slovenia (50 percent), and accounted for important shares in Hungary (35 percent), Croatia (25 percent), and Slovakia and Romania (20 percent each). Local shops and restaurants had a very important role in Slovenia (40 percent) and Croatia (37 percent). Sales to purchasing companies (dairies) dominated in Greece (90 percent), Serbia (80 percent), Bulgaria (75 percent) and Albania (64.9 percent), and also played an important role in Croatia (31 percent), Romania (30 percent) and Hungary (25 percent). In Armenia, all four targets were present but their distributions were not identified.

There were various numbers of dairies in the studied countries, and on-farm milk processing was not a general activity. In Armenia, Croatia and Slovenia more than 75 percent of goat farms had some kind of on-farm processing unit. In Hungary, this figure was 50–75 percent. In Serbia and Slovakia, only 10–30 percent of farms had their own processing units, while fewer than 10 percent of farms in other countries had on-farm processing.

Land areas used by goat farmers

Few data are available on the areas of land used by goat farmers in the studied countries (Table 10). In Georgia, all goat farms operate without land, as do half of the goat keepers in Armenia. Shares of farms without land are much lower in Hungary (16.4 percent), Greece (15 percent) and Croatia (4 percent). All goat farms have less than 3 ha in Albania, as do most of the goat farms in Hungary (53.2 percent) and significant shares of those in Greece (40 percent) and Armenia (30 percent). Farms of 3–10 ha dominate in Slovenia (70 percent) and also account for very high shares in Greece (40 percent) and Croatia (41 percent). In Serbia, most goat farms (60 percent) have 10–30 ha of land. This size category is also important in Croatia (15 percent), but accounts for limited shares in the other countries. The 30–50 ha category is significant in Serbia (20 percent), and some farms in Croatia (6 percent) and Hungary (3.1 percent) are also of this size. Larger farms of 50–100 ha keep goats in Croatia (2 percent) and Hungary (3.3 percent). In Hungary, some goat farms have 100–300 ha (3.3 percent) or more than 300 ha (1.4 percent). In the largest categories of land area, goat keeping and breeding is not the main activity; other agricultural activities are also practised.

Ownership of the land used

Few data were available on ownership of the land used by goat farmers in the studied countries (Table 11). Most of the land used by goat farmers belonged to other people. In Georgia, 100 percent of goat farms owned less than 10 percent of the land they used. In Armenia, half the farms owned less than 10 percent of the land they used, and the other half owned 10–20 percent. In the other countries, landownership was more evenly distributed. In Greece, 60 percent of farmers owned 30–50 percent of their land. This category was also significant in Serbia (40 percent), Hungary (35 percent) and Croatia (28 percent). Some 60 percent of Serbian goat farmers owned at least 50 percent of their land, as did 55 percent of farmers in Hungary, while the shares of this category in Croatia (38 percent) and Greece (10 percent) were smaller.

These data show that most of the land used by goat farmers was under other ownership; generally, most of the grass- and arable land needed for goat keeping was rented from somebody else. Grassland (permanent pasture) was rented mainly from local municipalities in most of the countries: Bulgaria (100 percent), Armenia (80 percent), Greece (65 percent), and Georgia and Serbia (60 percent each). In Croatia, the State (63 percent) was the dominant grassland owner from which pastures were rented. The State was also the most important owner in Hungary, although it accounted for only 30 percent of the total. Significant shares of grassland were rented from other landowners in Hungary, Serbia and Georgia (30 percent each), which implies that most of these owners were not involved in other agricultural activities. The share of goat farmers renting from other farmers was significant only in Hungary (20 percent), while this category played only a limited role in other countries.

Rental of arable land from local municipalities dominated in only two countries: Armenia (80 percent) and Croatia (68 percent). Shares in Hungary and Serbia (30 percent each) and Georgia (20 percent) were much lower, but still significant. The State accounted for a significant share of arable land rentals only in Hungary (35 percent). Other landowners had a dominating role in Greece (90 percent) and Serbia (60 percent), and were also significant in Bulgaria (50 percent) and Georgia (40 percent).

Labour used on farms

In most of the countries goat farming was a family business and only limited external labour was employed (Table 12). Most farms used only family members in Hungary (98.1 percent), Greece (90 percent), Croatia (85 percent), Bulgaria (80 percent) and Georgia (75 percent). Significant shares of farms were also in this category in Albania (34.5 percent) and Serbia (20 percent). Fewer than three external labourers were employed on 70 percent of the farms in Armenia. This category also dominated in Albania (65.4 percent) and Serbia (65 percent), and had an important role in Bulgaria (20 percent). The shares of farms employing three to five labourers were highest in Armenia (20 percent) and Serbia (15 percent). As the size of goat farms – particularly dairy farms – increased, the demand for external labour climbed, but only small shares of farms needed five to ten or more than ten labourers. These large farms employed labour for milking and milk processing in their own dairies.

Ages and education levels of goat farmers

The ages and education levels of goat farmers were not reported in about half of the countries (Table 13). Armenia and Georgia were exceptional cases, with respectively 70 and 40 percent of farmers being in the 30–40 years of age category. The age distributions in Croatia, Greece, Georgia, Hungary and Serbia were acceptable, but otherwise the goat farmer population showed a tendency for ageing. The dominant share was more than 40 years of age, and a large share was more than 60 years. Albania could not be listed in these categories, but about 1 percent of goat farmers were younger than 25 years of age, 69 percent were aged between 25 and 60 years, and 30 percent were more than 60 years.

The education levels of farmers varied from country to country, but were generally rather low. Elementary/primary school was the dominant education level in Greece (75 percent) and Albania (62.8 percent), and also accounted for a high share in Hungary (43.9 percent). The share of farmers educated as skilled labourers was highest in Albania (31.2 percent), but was rather low in other countries. The largest shares of goat farmers with at least secondary school education were in Croatia (69 percent), Armenia, Georgia and Serbia (50 percent each) and Hungary (45.4 percent). Large shares of goat farmers had college education in Armenia and Serbia (35 percent each), but university degrees were most common in Georgia (30 percent). In the other countries, studies of farmers' education levels have not yet been carried out.

Subsidies for goat farming

Subsidies for goat breeding and/or farming were rather low in the studied countries, with goat farmers in most countries receiving no direct subsidies. In Albania, farmers received €20/doe and €30/buck for taking part in gene conservation; farms with 10–50 pure-bred animals received €37.5/doe), and full-time goat farmers with 100–300 heads received €3.6/doe. Goat keeping was also subsidized in Bulgaria (€20/doe) and Croatia (€17/doe). In Hungary, a "de minimis" subsidy of €10/doe could be received on application. In Greece, goat farms could receive a subsidy under the SPS system based on the area of land used. In other European Union member countries (the Czech Republic, Hungary, Romania, Slovakia and Slovenia) goat farmers could receive subsidies under the SAPS system, but not directly for goat farming. Goats could also be considered supported animals under the agro-environmental subsidy system in Hungary. In Armenia, Georgia and Serbia, goat keeping/breeding was not subsidized. To rebuild the small ruminant sector, significant subsidies were given to farmers in the Russian Federation to reimburse them for the costs of increasing their breed stock capacity in all branches of the goat and sheep breeding sector. In 2013, these subsidies amounted to about €15 million. A similar system was utilized in the Republic of Moldova in 2013, with farmers receiving 100 lei/kg live weight to support the purchase of pure-bred sheep and goat breeding stock. In Montenegro, in 2012, 402 goat farms with more than ten goats received subsidies for a total of 18 538 breeding animals.

The need to improve profitability

The average profitability of goat keeping varied widely from country to country (Table 14) and has not been studied in some countries. Profitability seems to have been lowest in Georgia, with less than €10/doe/year (80 percent). In Serbia, the annual income per doe was €10–30 (100 percent). In Greece, 80 percent of farms could produce €30¬–50/doe/year. This category also accounted for 40 percent of farms in Hungary. In Croatia, 30 percent of goat farms produced €100–200/doe/year, with 25 percent of farms earning €50–100/doe/year and another 25 percent €200–300. In Armenia, 70 percent of farms were in the €100–200/doe/year category.

Conclusions

The information collected showed that goat numbers have been decreasing in all countries of the region except Romania. The main conclusions of the study can be summarized as follows:

• In most countries, goats are kept in small herds, with only small shares of profitable specialized goat farms (most of which are dairy herds).

• Local indigenous goat breeds are underappreciated because of their low profitability.

• Only limited shares of the goats kept are involved in nucleus breeding; the productivity of most goats is unknown.

• To increase the profitability of goat farming, all countries import exotic goat breeds, which are used mainly to improve milk production, but also to increase meat production.

• Exotic breeds are used in cross-breeding systems, but the use of pure-breeds is increasing rapidly.

• Nucleus breeding of goats is not very profitable, and the preservation and protection of local breeds cannot be carried out without serious financial support from government.

• The market for goat products is not well organized in the region; the meat market is particularly weak. Milk remains the dominant income source for most goat farms, but meat becomes the main product in some situations.

• Most goat farmers need basic training in using improved breeds and keeping indigenous breeds in more profitable systems. Those with some knowledge in these areas would benefit from advanced training.

• There is need for innovation in goat management and housing in all the studied countries. Modern milking equipment is also required to replace hand-milking.

• According to evaluations, there is strong demand for product development to improve the profitability of goat farming in all the studied countries.

• The profitability of goat farming seems to improve with increasing herd size.

• Limited subsidies for goat farmers are available in some countries, but these are insufficient to ensure the preservation of local breeds for the future.

• Goat farming needs similar help to that available to dairy cattle, chicken or pig farming to improve its ability to survive and be profitable and to preserve local domestic breeds adapted to specific environmental conditions.

Recommendations

Most Central, Eastern and Southeastern European countries need strong organizations for goat breeders and farmers to help them survive. Frequent regional meetings should be organized to discuss emerging results and develop useful cooperation.

Markets for goat milk products need urgent support in reaching the necessary level of development, and there is need to establish a market for goat meat in this part of Europe.

These countries require serious government support to the preservation, protection and improvement of local indigenous breeds. Without such support, exotic breeds are likely to dominate goat farming, while valuable old genetic stock slowly disappears.

Goat farmers need basic and further education in applying recent innovations and developments to their day-to-day goat managements in order to build a sustainable future.

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TABLE 1: GOAT FARM AND HERD SIZES IN CENTRAL AND EASTERN EUROPE

Country	Goats (no.)	Goat farms (no.)	% farms with < 10 heads	% farms with 10–30 heads	% farms with 30–50 heads	% farms with 50–100 heads	% farms with 100–200 heads	% farms with 200–500 heads	% farms with 500– 1 000 heads	% farms with 1 000 heads
Albania	810 000	138 226	22.6	39.2	23.3	9.2	3.9	1.1	-	-
Armenia	30.500	28	12	8	10	27	35	8	-	-
Belarus	68 000	?								
Bulgaria	293 639	65 487	66.78	3.21	2.01	0.83	0.34	-	-	-
Croatia	65 000	230	14	16	26	31	9	3	1	-
Czech Republic	24 000*	313	76.7	16.0	3.2	1.9	1.6	0.3	0.3	-
Georgia	70 000	Not known	20	20	-	60	-	-	-	-
Greece	4 821 000	138 251	60	10	13	5	5	6	1	-
Hungary–KSH	46 000	19 413	91.1	7.6	0.9	0.3	0.1	-	-	-
Hungary–MJKSZ	20 711	790	29.7	37.8	15.2	11.7	5.0	0.6	-	-
Macedonia (FYR)	63 585	5 746	77.74	17.21	2.82	1.76	0.40	0.07	-	-
Rep. of Moldova	120 000	?								
Montenegro	35 140	3 580	80,0	16,0	4,0					
Romania	1 605 860	280 000	21.2	14	18	18	15	8.4	3.1	2.3
Russian Fed.	2 090 000	?								
Serbia	225 077	3 000	-	20	-	40	25	15	-	-
Slovakia	35 000	898	70.9	20.4	4.2	2.6	1.3	0.45	-	0.11
Slovenia	26 351	158	60	30	7	2	1	-	-	-
Ukraine	664 800	?								

* Data refer only to registered goat farms

TABLE 2: NAMES AND DISTRIBUTIONS OF GOAT BREEDS IN CENTRAL AND EASTERN EUROPE

Country	Local breed goats (no.)	Exotic milk goats (no.)	Exotic meat goats (no.)	Local breeds				Imported (exotic) breeds		
				Milk	Meat	Wool	Down	Milk	Meat	Wool/ down
Albania	805 000	5 000		Dragobi, Has, Velipoje, Bulqari, Mat, Capore e Mokrres, Shyte, Liqenas, Dukat, Muzhake, Lara e Kallmetit, Native non classified				A; S		
Armenia	30 500	291		E&W Armenian				S; A; T; N		
Belarus	68 000*			Local native, Gorky				S; T; WR		
Bulgaria	293 639	2 000		Local goats, Bulgarian white				S; A		
Croatia	56 700	8 000	300	Balkan				A; S; BDE		
Czech Republic	23 580**	220	210	WSH, BSH				A; S; N; VB,	B; DD	ANG; CAS
Georgia	70 000*			Local				A; S		
Greece	4 821 000*			Skopelos, others				A; D; M;		
Hungary–MJKSZ	700	2 900	500	HN; HB; HM; HW				A; S; N; M	B	
Macedonia (FYR)	42 710	20 875		Balkan				A; S		
Rep. of Moldova	120 000*			Local				A; S		
Montenegro	35 140*			Balkan				A; S		
Romania	1 445 247	64.264	2 000	Carpatina, Banatian White				A; S		ANG
Russian Federa-tion	2 090 000*	18 000		Local goats		Soviet woo-len, Dagest-anian	Orenburg, Altai Mountain, Don, White Dagestanian	S; G;		
Serbia	53 000	8 000	-	Balkan				A; S	B	
Slovakia	32 500	2 500	-	WSH; BSH				A; S; N	C; D; B	
	MO; CAS									
Slovenia	21 000	5 000	300		DR			A; S	B	
Ukraine	665 000*			Local Ukrainian				A; S; T; N,		

* Total number of goats ** Data refer only to registered goat farms

A = Alpine; ANG = Angora; B = Boer; BDE = Bunte Deutsche Edelziege; BSH = Brown Shorthair; C = Cameron; CAS = Cashmere; D = Damascus; DD = Dutch Dwarf; DR = Dreznica; DU = Durine; E&W = Eastern and Western Armenian; HB = Hungarian Brown; G = Girgentana; HM = Hungarian Multicolour; HW = Hungarian White; HN = Hungarian Native; M = Murcia; N = Nubian/Anglo Nubian; VB = Valis Blackneck; WSH = White Shorthair.

TABLE 3: AVERAGE GOAT MILK YIELDS AND NUMBERS OF MILKING DAYS IN CENTRAL AND EASTERN EUROPE

Country	**Average milk yields (litres/year)**		**Number of milking days per year (% of goats)**					
	Local breeds	**Exotic breeds**	**< 150**	**150–180**	**180–210**	**210–250**	**250–300**	**> 300**
Albania	85–240	250–350	6.2	62.6	18.7	-	12.5	-
Armenia	100–450	800	Native 100%	C 10%	E 30%; C 70%	C 20%; E 30%	E 40%	
Belarus	300–400	700– 800			Local goats		Gorky	S; A; T; RW
Bulgaria	180–250	450–550	60	40	-	-	-	-
Croatia	200–350	550–750	3	7	16	48	18	8
Czech Republic	650–740	750–850	12	40	28	16	2.8	0.2
Georgia	150	500–700		60		40		
Greece	150	320	-	Local Greek	-	Skopelos	A; D; M	-
Hungary–KSH	–	–	-	-	-	-	-	-
Hungary–MJKSZ	190–600	420–880	13.43	21.84	16.43	18.44	18.24	11.62
Macedonia (FYR)								
Republic of Moldova	300	600–1000			Local goat		A; S	
Montenegro	100–160	400–500			Balkan	A; S		
Romania	300	850			local goat			A; S
Russian Federation								
Serbia	250–300	650–700		Balkan		A	S	
Slovakia	530–650	650–740	WSH 5.9%	WSH 87.8%	WSH 6.3%	-	-	-
			BSH 5.9 %	BSH 58.8%	BSH 35.3%			
			AN 27.3%	AN 45.4%	AN 27.3%			
Slovenia	300–400	480–600		-	Dreznica goat	S	A	-

A = Alpine; S = Saanen; D = Damascus; RW = Russian White; M = Murcia; WSH = White Shorthair; BSH = Brown Shorthair; AN = Anglo Nubian; T = Toggenburg; E = exotic; C = local x exotic cross-breed.

TABLE 4: AVERAGES AGES OF DOES IN CENTRAL AND EASTERN EUROPE

Country	% of goats			
	< 2 years	2–4 years	4–6 years	> 6 years
Albania	18.2	48.6	32.9	0.3
Armenia	8	80	10	2
Bulgaria	-	-	-	-
Croatia	18	29	38	15
Czech Republic	-	-	-	-
Georgia	50	30	20	-
Greece	20	50	20	10
Hungary–MJKSZ	16.6	31	28.5	23.9
Romania	-	-	-	-
Serbia	20	15	40	25
Slovakia*	21.6	29.0	22.6	26.8
Slovenia	43	25	17	15

* Data refer only to nucleus herds

TABLE 5: GOAT PRODUCTION AND MILKING SYSTEMS IN CENTRAL AND EASTERN EUROPE

Country	Production systems (% of farms)			Milking systems (% of farms)		
	Traditional (extensive) grazing	Improved system (grazing + supplement)	Intensive indoor	Hand-milking	Simple machine milking	Modern milking parlour
Albania	36.20	63.77	0.03	98.8	1.192	0.008
Armenia	70	30	-	90	8	2
Belarus	98	2	-	98	1.6	0.2
Bulgaria	70	30	-	70	20	10
Croatia	10	30	60	10	80	10
Czech Republic	no exact data available	in. h.	< 10 goats	< 30 goats		
Georgia	100	-	-	100	-	-
Greece	5	85	10	70	20	10
Hungary–KSH	35	45	20			
Hungary–MJKSZ	75	20	5	10	70	20
Macedonia (FYR)	80	20		98.5	1,0	0.5
Republic of Moldova*	94	5	1	94	5	1
Montenegro	50	40	10	80	15	5
Romania	77	20	3	80	15	5
Russian Federation*	90.1	9.89	0.01	90.1	9.89	0.01
Serbia	85	10	5	70	25	5
Slovakia**	30	70	-	64	34	2
Slovenia	8	90	2	2	1	97
Ukraine*	99.2	0.79	0.01	99.2	0.79	0.01

* Estimated ** Data refer only to nucleus herds

in. h. = individual households

TABLE 6: GOAT MILK PRODUCTION ON FARMS IN CENTRAL AND EASTERN EUROPE

Country	% of farms					
	< 5 000 litres	5 000–10 000 litres	10 000–30 000 litres	30 000–50 000 litres	50 000–100 000 litres	300 000–500 000 litres
Albania	68.4	22.6	6.5	1.8	0.7	-
Armenia	8	70	20	2	-	-
Bulgaria	no relevant data					
Croatia	17	21	30	25	5	2
Czech Republic	no relevant data					
Georgia	-	100	-	-	-	-
Greece	10	10	50	15	15	-
Hungary–KSH	97.76	1.78	0.32	0.1	0.02	0.02
Romania	no relevant data					
Serbia	-	20	30	20	30	-
Slovakia	no relevant data					
Slovenia	18	30	38	12	2	-

TABLE 7: PURCHASE PRICES OF GOAT MILK AND SELLING PRICES OF CHEESE IN CENTRAL AND EASTERN EUROPE

Country	Milk prices (% of farms)					Cheese prices (% of farms)			
< €0.3/litre									
€0.3–0.4/litre									
€0.4–0.5/litre	€0.5–0.6/litre	> €0.6/litre							
< €6/kg									
€6–10/kg	€10–20/kg	> €20/kg							
Albania	-	12.2	83.5	4.3	-	100	-	-	-
Armenia	-	100	-	-	-	100	-	-	-
Bulgaria	-	100	-	-	-	100	-	-	-
Croatia	-	100	-	-	-	-	10	85	5
Czech Republic	-	-	-	-	€1.3/litre	-	-	100	-
Georgia	-	100	-	-	-	100	-	-	-
Greece	-	-	-	85	15	-	100	-	-
Hungary–MJKKHE	-	10	35	40	20	15	45	35	5
Romania	15	70	10	5	-	-	-	-	-
Serbia	-	-	100	-	-	-	100	-	-
Slovakia	-	-	-	10	90	5	80	10	10
Slovenia	-	-	-	-	€0.7–0.8/litre	-	-	€11/13–19/kg	-

TABLE 8: WEANING AGES, LIVE BODY WEIGHTS AT SALE AND SELLING PRICES OF KIDS IN CENTRAL AND EASTERN EUROPE

Country	Weaning age (% of farms)					Live body weight at sale (% of farms)				Price (% of farms)			
	One day	One week	One month	Two month	Above two months	8–12 kg	12–16 kg	16–20 kg	Above 20 kg	Under 2 €/kg	Between 2–3 €/kg	Between 3–5 €/kg	Between 5–8 €/kg
Albania	-	-	-	21.5	78.5	21.5	73.5	5.0	-	-	-	-	100
Armenia	-	-	-	80	20	-	10	10	80	-	-	100	-
Bulgaria	10	-	-	10	80	15	50	35	-	-	100	-	-
Croatia	5	10	41	35	9	5	15	62	18	-	20	70	10
Czech Republic	no available data	no available data	-	60	40	-							
Georgia	-	-	80	20	-	-	20	70	10	-	90	10	-
Greece	-	-	-	80	20	-	80	10	10	-	95	5	-
Hungary-MJK-KHE	5	5	20	60	10	30	60	10	-	-	100	-	-
Romania	-	-	-	-	-	-	-	-	-	-	-	-	-
Serbia	50	-	20	30	-	-	15	50	35	-	100	-	-
Slovakia	-	-	80	20	-	20	70	5	5	70	20	10	-
Slovenia	2	-	30	68	-	-	-	30	70	-	-	€4/kg	-

TABLE 9: TARGETS OF SURPLUS MALE KIDS, MILK AND MILK PRODUCTS IN CENTRAL AND EASTERN EUROPE

Country	Surplus kids (% of farms)					Milk and milk products (% of farms)			
	On-farm consumption	Local sales via informal relationships	Local shops	Sale for slaughter (incl. export)	Other target (zoo for feed)	On-farm consump-tion	Local sales via informal relationships	Local shops/ restaurants	Sales to purchasing dairies
Albania	21.8	34.4	43.8	-	-	15.3	12.6	7.2	64.9
Armenia	50	30	28	-	2	✓	✓	✓	✓
Bulgaria	15	85	-	-	-	10	15	-	75
Croatia	12	75	13	-	-	8	25	37	31
Czech Republic	no exact data available					no exact data available			
Georgia	80	10	10	-	-	80	10	-	10
Greece	3	5	30	62	-	10	-	-	90
Hungary -MJKSZ	69	29	0.49	1.5	0.01	30	35	10	25
Romania	40	30	15	13	2	40	20	10	30
Serbia	-	100	-	-	-	10	10	-	80
Slovakia	80	10	-	10	-	60	20	10	10
Slovenia	1	50	20	29	-	10	50	40	-

TABLE 10: AREAS OF LAND USED BY GOAT FARMERS IN CENTRAL AND EASTERN EUROPE (% OF FARMS)

Country	No land	< 3 ha	3–10 ha	10–30 ha	30–50 ha	50–100 ha	100–300 ha	> 300 ha
Albania	-	100	-	-	-	-	-	-
Armenia	50	30	15	5	-	-	-	-
Bulgaria	-	-	-	-	-	-	-	-
Croatia	4	22	41	25	6	2	-	-
Czech Republic	-	-	-	-	-	-	-	-
Georgia	100	-	-	-	-	-	-	-
Greece	15	40	40	5	-	-	-	-
Hungary–KSH	16.4	53.2	10.4	8.9	3.1	3.3	3.3	1.4
Romania	-	-	-	-	-	-	-	
Serbia	-	-	20	60	20	-	-	-
Slovakia	-	-	-	-	-	-	-	-
Slovenia	-	20	70	10	-	-	-	-

TABLE 11: SHARES OF LAND OWNED BY GOAT FARMERS AND DISTRIBUTION OF RENTED ARABLE AND GRASSLANDS IN CENTRAL AND EASTERN EUROPE

Country	Land owned by goat farmers (% of farms)					Rented grassland (% of farms)				Rented arable land (% of farms)			
	< 10%	10–20%	20–30%	30–50%	> 50%	From local municipality	From State	From other landowners	From other farmers	From local municipality	From State	From other land-owners	From other farmers
Albania	no relevant data												
Armenia	50	50	-	-	-	80	10	5	5	80	10	5	5
Bulgaria	no relevant data	100		-	-			50	50				
Croatia	5	12	17	28	38	23	63	5	9	68	5	12	15
Czech Republic	no relevant data												
Georgia	100	-	-	-	-	60	-	30	10	20		40	40
Greece	5	5	20	60	10	75	10	10	5			90	10
Hungary–KSH	-	10	20	35	55	20	30	30	20	30	35	20	15
Romania	no relevant data												
Serbia	-	-	-	40	60	60	10	30	-	30	10	60	
Slovakia	no relevant data												
Slovenia	no relevant data												

TABLE 12: NUMBERS OF HIRED LABOURERS WORKING ON GOAT FARMS IN CENTRAL AND EASTERN EUROPE (% OF FARMS)

Country	None (only family members)	< 3	3–5	5–10	> 10
Albania	34.5	65.4	-	0.1	-
Armenia	5	70	20	3	2
Bulgaria	80	20	-	-	-
Croatia	85	10	5	-	-
Czech Republic	-	-	-	-	-
Georgia	75	10	10	5	-
Greece	90	10	-	-	-
Hungary–KSH	98.1	1.0	0.4	0.2	0.3
Romania	-	-	-	-	-
Serbia	20	65	15	-	-
Slovakia	-	-	-	-	-
Slovenia	-	-	-	-	-

TABLE 13: AGES AND EDUCATION LEVELS OF GOAT FARMERS IN CENTRAL AND EASTERN EUROPE

Country	Age of farmers (% of farms)					Education level of farmers (% of farms)				
	< 30 years	30–40 years	40–50 years	50–60 years	> 60 years	Primary school	Skilled labour	Secondary school	College	University
Albania	?	?	?	?	?	62.8	31.2	2.8	-	3.2
Armenia	4	70	10	6	2	2	10	50	35	3
Bulgaria	no data available	no data available								
Croatia	11	18	27	32	12	7	11	69	8	5
Czech Republic	no data available	no data available								
Georgia	5	40	30	20	5	5	5	50	10	30
Greece	5	10	30	25	30	75	10	10	5	-
Hungary–KSH	5.2	20.0	22.6	23.7	28.5	43.9	-	45.4	8	
Hungary–MJKSZ	no data available					no data available				
Romania	no data available					no data available				
Serbia	-	-	50	35	15	15	-	50	35	-
Slovakia	no data available					no data available				
Slovenia	no data available					no data available				

TABLE 14: PROFITABILITY OF GOAT FARMING IN CENTRAL AND EASTERN EUROPE (% OF FARMS)

Country	< €10/ doe/ year	€10–30/ doe/ year	€30–50/ doe/ year	€50–100/ doe/ year	€100–200/ doe/ year	€200–300/ doe/ year	> €300/ doe/ year
Albania	not yet studied						
Armenia	-	-	-	20	70	10	-
Bulgaria	not yet studied						
Croatia	-	-	10	25	30	25	10
Czech Republic	not yet studied						
Georgia	80	20	-	-	-	-	-
Greece	-	10	80	8	2	-	-
Hungary–MJKKHE	5	15	40	20	15	5	-
Romania							
Serbia	-	100	-	-	-	-	-
Slovakia	not yet studied						
Slovenia	not yet studied						

ORGANIZATION AND SHIFTS IN THE GENETIC SELECTION AND BREEDING OF GOATS TO ADDRESS CURRENT ENVIRONMENTAL ISSUES IN LIVESTOCK ACTIVITIES

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Abstract

A major part of the world's ecosystem resources (water, soils, forests, biodiversity) has been highly degraded by current agrofood systems. In addition, an important social crisis caused by low incomes, rural emigration, the loss of rural employment and indebtedness is concomitant to the environmental crisis. Within this context, the international community and institutions have signed an agreement to define a common strategy for tackling the challenges that humankind has to face. The dominant paradigm is still the classical one of progress and intensification, but for several years there has been a movement for redefining and diversifying agricultural systems towards an environmental transition. The external negative effects of livestock as an important cause of the emission of carbon dioxide (CO_2) and environmental damage have recently increased. The future of livestock sectors, as well as other agrofood systems, has, therefore, to be questioned to find ways of decreasing these negative externalities and developing more sustainable systems.

Among the different types of livestock, the general opinion is that goats would be well adapted to limiting these negative externalities through their ability to valorize rangelands, shrubs and by-products. This paper discusses this proposal through a general analysis of goat production systems and a review of the situation of goat breeds and

genetic selection for all goat products – meat, milk or fibre – throughout the world. Possible strategies regarding the reorientation of production systems to face the socio-environmental issues are discussed, along with their potential application in Europe.

Key words: goat breeding, agro-ecological transition, goat breeding, local breeds, livestock policy

Introduction

The livestock sector is highly affected by the systemic crisis that has been facing the world for several decades. This urgent situation involves environmental, energy, social, financial and political issues, and, so far, the only responses to these difficulties proposed by public and economic powers have focused on finding ways to restore growth. Growth would create more wealth, jobs, happiness and prosperity, but – as underlined by Jackson (2009) – an economy based on perpetual expansion in a world with limited resources is ecologically unsustainable, socially problematic and economically unstable.

The objective of this paper is to explore ways of facing, and possible solutions to, these challenges to the goat sector – a very specific subsector in the world of livestock. It focuses on genetic selection and breeding issues and their relations with environmental factors. These discussions are elaborated at the global level with special attention to the development of possible strategies for goat farming in Central and Eastern Europe.

Materials and method

The paper is based on bibliographical references and statistics. It starts by outlining the current situation of genetic selection in the goat sector and explains how important this selection is to current environmental issues. Different experiences are described and compared to identify possible ways of developing and improving the environmental efficiency of goat production systems and organization. Contributions from research are explored through bibliographical analysis of data basis and several other references.

Results and discussion

The current situation of genetic selection and breeding in the goat sector

Breeding and genetic selection have been an important lever of progress in livestock production for the last 50 years.

The increased productivity of livestock breeds selected to valorize rationalized nutrition programmes has enabled more than fivefold growth in milk yields and in conversion rates in pig, poultry and cattle meat production.

Although the goat sector has often been undervalued economically and commercially during the twentieth and twenty-first centuries, several specific dairy and goat meat sectors have been developed locally with significant outputs and results. This is particularly true of the dairy goat sector in France, where the organization and selection of Alpine and Saanen breeds are often considered a model for success. In 2013, in France, average milk production was 915 kg/doe/lactation for Alpine dairy goats and nearly 1 000 kg/doe/lactation for Saanen goats registered in the milk control system (Institut de l'élevage, 2012). Over the past 20 years, this productivity has continued to grow at about 20 percent per year.

However, in spite of this success, most goats all over the word belong to uncharacterized populations or unselected local breeds. Among these breeds are the 136 identified by Gall (1996), but this number now needs to be updated. Far fewer breeds are involved in true selection schemes: Dubeuf and Boyazoglu (2009) estimate about 20. The conservation of animal breeds is an important issue for world biodiversity (FAO, 2000), while for goats the preservation of local genotypes is of major importance in favouring use of the natural resources of rangelands (Hoffmann, 2004). Some rare breeds with small populations have been identified and selected, mainly for conservation. In France, for instance, seven rare goat breeds are supported through various types of organization, but these management programmes meet points of tension between conservation and development objectives (Lauvie et al., 2011).

Dynamics of goat activities and environmental issues

Goats have been the most rapidly expanding livestock subsector for more than 20 years. The world goat population has increased by about 66 percent over the past 20 years, compared with 14 percent growth for cattle (FAOSTAT, 2013). However, most of this growth has occurred in low-income countries (which account for about 80 percent of the world's goats), and most of the goat milk or meat produced is for own consumption on farms, with a very small share traded – probably less than 5 percent (Dubeuf et al., 2004).

This means that most goat production systems are managed by smallholders with low incomes. These production systems are based on low inputs, low investments and the use of natural resources (rangelands, scrub, forage trees or by-products). A recent study has shown (IGA/IFAD, in press) that in favourable conditions and with few investments, goats can be profitable for poor households and can help them to rise out of poverty, with possible significant impacts not only for communities but also at the regional level. Goat farming can be introduced anywhere, and not only to fight poverty. Compared with other animals, goats would be a better lever for developing the agro-ecological principles for animal production defined by Altieri (1983), which promote ecological practices not only for technical and economic purposes but also to promote social improvements:

Goat production systems are generally integrated into complex livelihood systems and are multifunctional in providing – often simultaneously – milk, meat, fibre, manure and sometimes even recreational activities. In addition, goat products are often typical to their local areas, and their marketing could be improved by emphasizing the environmental role of goats and the organic production model as part of the development of tourism in many low-resource areas.

Goats, particularly local rustic genotypes, have a high capacity to valorize low-quality forage and recover rapidly after periods of water and food shortage (particularly for meat production), which would be a major advantage in facing climate change.

Goats are well adapted to grazing on rangelands and, when correctly managed, can protect and enhance biodiversity. Many references confirm that goat grazing does not degrade rangelands, in spite of the many claims to the contrary.

Perspectives and orientation of goat research focusing on genetics

A survey of the scientific areas investigated by research between 2005 and 2011 (Table 1) shows that most publications are dedicated to biotechnical science, while strategic issues are not frequently considered.

Nearly half of research projects are oriented towards nutrition and improving the efficiency of feeding in somewhat intensified controlled systems. Publications on genetics and breeding are less numerous. Genomic research has advanced more rapidly since the goat genome was sequenced in 2010, with outputs that include (Laroque et al., 2012) genetic control of the casein composition; selection to improve resistance to scrapie disease; identification of the gene that controls milking speed; and development of selection on a larger number of genetic markers. This research has been undertaken through collaboration among France, China, Malaysia and the Netherlands. Although some local breeds – such as Creole, Savanna and Kacang – have been studied, most research has involved Saanen, Alpine and Boer breeds.

These observations are consistent with the general conclusions of Morand-Fehr (2000), given that most research on goats focuses on intensive dairy systems and that goats are an easy animal to work with in developing scientific knowledge. Research on strategic social and environmental issues is still very scarce. The survey also confirmed that multidisciplinary approaches are still infrequent. There are still few links between human social sciences and animal sciences, and scientific knowledge to guide actions that consider both social and environmental issues is lacking.

The innovations needed to improve the environmental performance of goats

Many innovations could improve the environmental performance of goats (Bocquier et al., 2011). A main issue is improving the animals' capacity to adapt to changing conditions. This objective could be achieved by developing innovative observation criteria to help breeders or extension agents manage pasture and grazing more dynamically. Nutritional risks could be managed by observing the diversity of pastoral resources. Territorial incentives and changes in regulations to promote environmental practices could also be considered as possible innovations to support environmentally safer goat breeding. So far, animal breeding has been based mainly on individual selection. The coordination of reproduction cycles in groups of animals, and the organization of animal replacement according to herd management objectives would also be innovations to develop (Santucci, 1991). The complex relationship between goat farming and country planning needs to be modelled to facilitate an approach that allows changes to production systems. All these innovations emphasize the need to articulate scientific and expert knowledge.

Environmental issues could be incorporated into all research topics. For reproduction control, hormonal treatments should be decreased and, ultimately, suppressed, to be replaced by methods associated with light treatment and male effects. Parasitism could be controlled by alternative natural treatments rather than chemical ones.

Precision breeding is now applied less in goat than in other livestock production. On more technical farms, precise monitoring of animals using electronic tools could enable examination of individuals' behaviour to optimize feeding or reproduction, the challenge being to decrease the use of fossil fuel and the greenhouse gas emissions by unit produced.

Conclusions

In Eastern and Central Europe, goat cheese production systems have good prospects. Most of the innovations mentioned in the previous section could be implemented. Public authorities would need to be involved; their awareness of the need to transition to agro-ecological practices and the role of goats has to be enhanced so that they can define appropriate public policies. These activities are public services and should not be provided by private companies because they involve public goods (pastoral and protected areas, marginal lands, rural communities, preservation of local breeds). To promote social capacities, training and extension would be a key factor in favouring these innovations.

For the past 40 years, the number of jobs in agriculture and livestock has dramatically decreased as a consequence of constantly increasing productivity. Social and environmental problems lead societies to change their paradigms. In many countries, underemployment is still a severe problem. In contrast, goat farming produces positive environmental externalities for preserving biodiversity, natural ecosystems and landscapes. So far, remuneration for these externalities has not been fully debated, but such innovations could also be particularly relevant for goat farming.

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TABLE 1. MAIN TOPICS QUOTED FROM THE WEB OF SCIENCE IN SMALL RUMINANT RESEARCH AND LIVESTOCK SCIENCE, 2006 AND 2011

Journal	Marketing, development, management and production systems	Nutrition	Genetic breed-ing	Physiology	Pathology and parasitology	Technology	Reproduction
Small Ruminant Research (1 160)	219 (18.9%)	495 (42.6%)	287 (24.7%)	338 (29.1%)	315 (27.1%)	26 (2.2%)	227 (19.5%)
Livestock Science (1 470)	334 (22%)	770 (52%)	345 (23.4%)	547 (37.2%)	141 (9.5%)	23 (1.5%)	233 (15.8%)

Source: Dubeuf, 2011.

GOAT BREEDING IN ROMANIA

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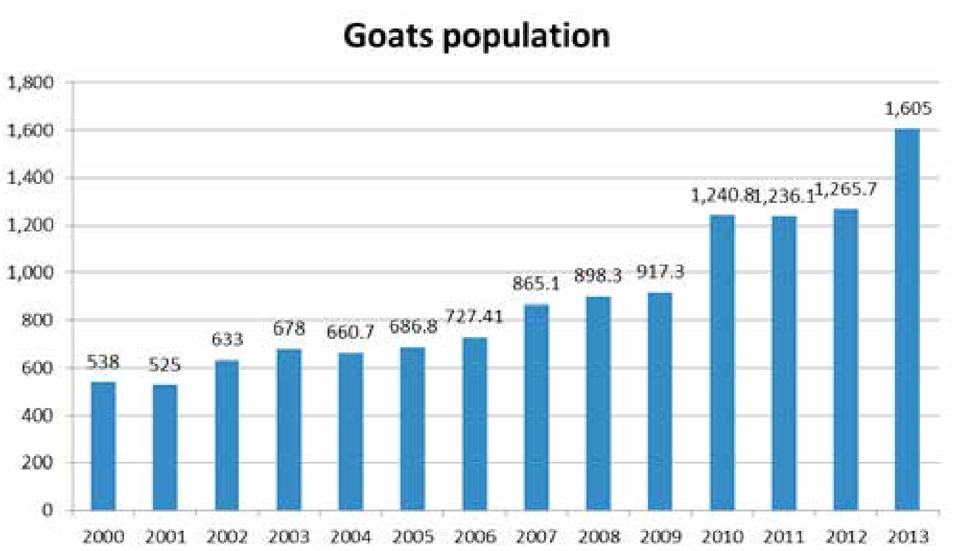
Abstract

This paper is based on a survey of the current situation of goat breeds in Romania. It proposes a scheme for a breeding programme.

In recent years, the goat sector has increased significantly, with the goat population increasing about threefold between 2000 and 2013 (Figure 1).

FIGURE 1. EVOLUTION OF THE GOAT POPULATION IN ROMANIA, 2000–2013



The main features of goat production systems in Romania can be summarized as follows:

- Practically all goat production systems are of low-input type.
- About 80 percent of goats are used for milk and meat production on smallholder subsistence and part-time farms (with between one and three goats per farm).
- About 7 percent of goats are kept on small commercial farms and 5 percent on large commercial farms, generally in combination with sheep (representing about 10 percent of the total sheep population).
- There are very few specialized goat farms (with 20–100 goats each) because the market demand for goat milk, cheese and meat is negligible.
- The goats of subsistence and part-time farmers are organized into flocks and pastured around villages during the day.

- Breeders are organized in the Romanian National Association of Goat Breeders.
- The average number of goats per farm is 9.16 heads (Table 1).

TABLE 1. AVERAGE NUMBERS OF GOATS PER FARM IN ROMANIA

Farm size	No. of farms	% of farms	No. of goats	% of goats	Average goats/ farm
< 10 goats	113 796	86.40	501 913	40.09	4.30
11–50 goats	1 365	10.60	424 305	3.89	31.08
> 50 goats	3 848	3.00	325 761	26.50	79.27
Total	128 009	100.00	1 251 979	100.00	9.16

Source: ANCC Caprirom, 2011.

The main goat breeds in Romania are Carpathian, Banat White, Alpine and Saanen. The most widespread in the country is the Carpathian breed, with 950 000 heads (Table 2).

TABLE 2. GOAT BREEDS IN ROMANIA

Breed	Population	Average milk production (litres/lactation)
Carpathian	950 000	220–350
Saanen–Carpathian cross	100 000	220–480
Pure and mixed Angora	100	-
Banat White	100 000	350–400
Alpine–Saanen cross	100 000	> 850
Other breeds	20 000	
Total	1 270 000	

The Carpathian goat

The Carpathian breed (Photo 1) is well adapted to climate conditions, but has very low lactogenic productive potential compared with the Saanen and Alpine breeds raised in European Union countries.

Photo 1. Carpathian goat (Horia Grosu, 2012)

The following are the morphologic and productive traits of the Carpathian goat:

- It is a medium-sized, mixed-haired, multicoloured goat with twisted horns and a dairy conformation.
- Long hair represents about 85 percent of the total weight of its hair, is 6.85–20.0 cm long and has a fineness of 70–76 microns.

- Short hair (about 15 percent of the total) is 2.7–3.11 cm long and has a fineness of 18–24 microns depending on the goat population.
- Its hair colour is grey, reddish, black or spotted.
- Live weights are 38.5–52.5 kg for females and about 56.7 kg for males.
- Its withers are 61.72–69.72 cm high.
- Carpathian goats are kept mainly for milk production.
- Milk production recorded for approximately nine months averaged 240–280 litres, with a peak of 450 litres, sometimes even reaching 800 litres. Fat content is 4.5–5 percent.
- Nearly all meat is produced from suckling, early spring kids aged 1–2 months and of 8–14 kg live weight, and reformed goats.
- The reproduction rate is about 140 percent.
- Newborn single females weigh about 2.9 kg, single males about 3.1 kg and twins about 200 g less than these weights.
- Goats are first used for reproduction at the age of 9–12 months.
- Intensively fattened kids (fed 70 percent concentrate feed) have a higher dressing percentage and fatness than non-intensively fattened kids (fed 40 percent concentrate feed).

The future potential of the breed can be summarized as follows:

- The breed is adapted to the local climate, management systems and parasitism, and to the support capacity of local vegetation.
- Its genetic improvement requires:
- clarification of its genetic population structure;
- introduction of systematic recording of production data;
- improvements in management systems and the support capacity of local vegetation.

The authors conclude that it is not advisable to rely on the use of foreign breeds for further genetic improvement.

- Imports of other breeds must be minimized.

Recommendations

The following are priority actions for enhancing the management of goat genetic resources:

- Establish a coherent and comprehensive breeding programme and policy, similar to other milk and kid improvement programmes.
- Minimize the replacement of native breeds by exotic breeds, because it is not possible to import the exotic breeds' ecosystems.
- Most imported breeds are extinct.

To develop goat production systems, there is need for:

- a clear governmental legislative framework for the development of:
- commercial goat farms;
- sustainable, high-profit production systems that are vertically integrated;
- an economically and technically strong goat association;

- systematic awareness raising to show that:
- in some conditions, goats can compete economically with cattle and sheep;
- goats have a large role in food security;
- a systematic action plan for creating an internal market for goat products;
- clear government support for:
- implementation of high-profit production systems;
- research into goat taxonomy.

Breeding programme

To estimate the effects of genetic improvements on milk yields in the Carpathian goat, the authors considered the genetic and phenotypic parameters listed in Table 3.

TABLE 3. GENETIC AND PHENOTYPIC PARAMETERS OF MILK YIELDS IN CARPATHIAN DAIRY GOATS IN ROMANIA

No.	Parameter	Unit	Value
1	Milk average	kg	275
2	Standard deviation	kg	55
3	Coefficient of variation	%	20
4	Phenotypic variance (VP)	kg2	3 025
5	Heritability	0.25	0.25
6	Genetic variance	kg2	756.25

Selection objective (H): Improvement of breeding value of males for milk yield:

$$H = A_t$$

Selection Index (I) for milk yield :

$$I = b_1 \cdot \overline{P}_{MOTHER} + b_2 \cdot \overline{P}_{HALF\_SISTERS}$$

$$V = \begin{bmatrix} \frac{1+(m_1-1)\cdot R}{m_1} & 0 \\ 0 & \frac{\frac{1+(m_2-1)\cdot R}{m_2}+(n-1)\cdot t}{n} \end{bmatrix} \cdot V_P = \begin{bmatrix} 1555.2 & 0 \\ 0 & 296.5 \end{bmatrix}$$

$$C = \begin{bmatrix} 0.5 * h^2 \\ 0.25 * h^2 \end{bmatrix} \cdot V_P = \begin{bmatrix} 364.5 \\ 182.25 \end{bmatrix}$$

$$b = C'V^{-1} = [364.5 \quad 182.25] \cdot \begin{bmatrix} 1555.2 & 0 \\ 0 & 296.5 \end{bmatrix}$$

$$b = [0.2344 \quad 0.6148]$$

$$\downarrow$$

$$b_1 = 0.2344$$

$$b_2 = 0.6148$$

So, the selection criteria (I) will be as follows:

$$I = 0.2344 \cdot \overline{P}_{Mother} + 0.6148 \cdot \overline{P}_{HALF\_SISTERS}$$

Response to selection per generation (R):

$$R_{Male} = r_{HI} \cdot i \cdot \sigma_H = 0.5205 * 1.0915 * 27 = 15.3381$$
$$R_{Female} = 0$$

$$\overline{R} = \frac{R_{Male} + R_{Female}}{2} = \frac{15.3381 + 0}{2} = 7.67\_kg\_milk$$

Length of intervals:

$$L_{DD} = \frac{48*1 + 48*2 + 24*3}{120} = 1.8\_years$$

$$L_{SD} = \frac{96*1 + 24*2}{120} = 1.2\_years$$

$$L_{SS} = 2\_years$$

$$L_{DS} = 3\_years$$

$$\overline{L} = \frac{L_{DD} + L_{DS} + L_{SS} + L_{SD}}{4} = \frac{1.8 + 3 + 2 + 1.2}{4} = 2\_years$$

$$\Delta G_{kg} = \frac{\overline{R}}{\overline{L}} = \frac{7.67}{2} = 3.84\_kg\_milk$$

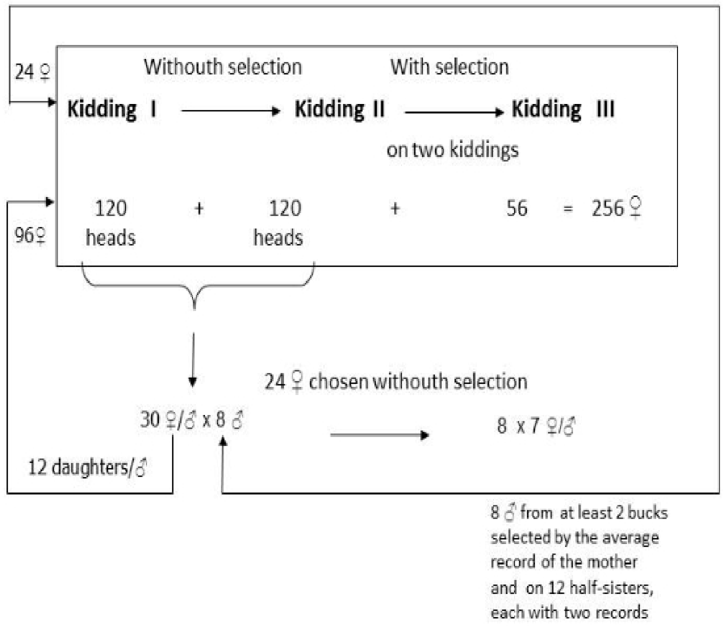
$$\Delta G_{\sigma_A} = \frac{\Delta G_{kg}}{\sigma_A} = \frac{3.84}{729} = 0.0053\_\sigma_A$$

$$\Delta G_{kg} = \left(\frac{\Delta G_{kg}}{\overline{P}_{Milk}}\right) * 100 = \left(\frac{3.84}{275}\right) * 100 = 1.4\_\%$$

If this type of selection is performed, the milk yield could increase by 1.4 percent or 3.84 kg/doe/year.

The proposed breeding scheme for a flock of 256 dairy goats could be as shown in Figure 2.

FIGURE 2. SCHEME FOR IMPROVING MILK YIELDS IN CARPATHIAN GOATS (BASED ON A FLOCK OF 256 DAIRY GOATS)



Source: Adapted from the KING programme for sheep, 1961; cited in Draganescu (1979).

Instead of more complicated breeding schemes, the proposed scheme could be used for at least the first few years.

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GOAT BREEDS AND BREEDING PROGRAMMES IN HUNGARY

Sándor Kukovics[18] and Gábor Baranyai[19]

Abstract

While before the First World War, there were more than 250 000 heads of breeding goats within the present size of Hungary, today only about 40 000 heads are registered in the data book of the Central Office of Statistics, of which fewer than 18 000 heads were officially registered in 2013.

After the Second World War, there were many goat breeds in Hungary (Alpine, Saanen, Toggenburg, Charmois-coloured mountain goat, etc), but Saanen types (white) accounted for about 70 percent of the total, and fawn-coloured goats for 30 percent. In the 1970s, a new wave of breeding started, with imported stocks from the Alpine regions; and imports continued in the early 1980s and mid-1990s and are still going on.

In the early 1990s, societies were founded for managing the breeding of imported breeds. In 1998, the Hungarian Goat Breeders' Association was established, and a new breeding programme was started in 1999 to develop Hungarian White, Hungarian Brown and Hungarian Multicolour breeds. After ten years of successful activity, these breeding projects were handed over to the Hungarian Sheep Breeders'Association at the end of 2008. By 2013, a couple of hundred Saanen and Alpine pure-bred goats remained in nucleus herds, along some pure-bred Nubian and Boer goats. From the Hungarian goats, those with long hair were selected out, and since 2010 have been referred to as "Hungarian Indigenous goats", with a dominant part of the goat population, again, not belonging to any specific breed.

Introduction

To understand the present state of Hungarian goat husbandry a short history should be outlined.

From a sociological point of view, goat husbandry in Hungary has undergone some interesting changes over the last 110 years (Kukovics, 2001).

The number of goats declined between 1880 and 1904, from 236 352 to 206 449 heads. Later, "the last conscription of 1945 registered 59 000, the increasing population reached in May of 1947 some 102 000", but the area referred to in these later figures was only one-third of the earlier one, following the Peace Treaty of Trianon (Paris) in 1920. The

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Central Bureau of Statistics (1998) records that the population of goats grew gradually until 1953, when the process was reversed; goat numbers started to increase again in the 1990s (Kukovics, 2001).

Goats were certainly present in the Carpathian basin a couple of thousand years ago, although no distinct local breed can be identified from that time. Almost all the indigenous population is a kind of fallow breed. There was wide variability in its colours, sizes, horn characteristics, length of hair and performance.

Kukovics (2001) cited Rezső Károly Rezső from 1910, who found a wide variability in goats: "The Hungarian goat population is utterly mixed, thus no distinct varieties could be recognised. Main differences are observed in the colour and the length of hair. However, neither of those traits nor the form of horns are coupled with each other and the performance of milk yield. Most abundantly, the white goats of medium long fur are found all over the country, but especially in Nyitra, Pozsony and Temes counties. Black goats occur too, pure or spotted, sometimes entirely black-bally goats are met. Moreover, entirely or flecked red goats in combination with other colours can be seen."

Between and after the two world wars, development of the Hungarian White, Improved White, Improved Roe-coloured and Hungarian Brown breeds were officially organized (Kukovics, 2001). According to the plans, 70 percent of goats were to be white (Saanen type) and the remaining 30 percent brown (Chamoise Alpine type, or fawn-coloured). Unfortunately, these breeding works were stopped by the socialist organization of the country's economy in the late 1950s. Molnár (1996, cited in Kukovics, 2001), discussing native goats, mentioned their long hair as a criterion. Goats with long hair distributed all over the body, were described as "tincses" ("tressy"), and those with hair concentrated on the hind-legs were referred to as "gatyás" ("rough-legged"). The latter type is considered a variant of uncontrolled segregation in hybrids arising from the crossing of native and Western breeds.

In the 1970s, a new wave of breeding started with imported stocks from the Alpine regions. Repeatedly, in the early 1980s and mid 1990s, imported animals improved goat populations, and a degree of uniformity was gained.

Again the question arises: What was the Hungarian native goat like? The variable fallow native goat (called native goats) has not achieved the status of a breed, but certain traits are common to this native population, which have been widespread across Hungary since ancient times. Types were distinguished according to whether they occurred in the mountains or on the plains (lowlands). Variability was conspicuous because no breeding objectives were followed to establish the basic traits of a distinct "breed". The animals were small or medium-sized, with large horns (including on most does), long hair of various colours (white, grey, brown, red, black, pied). Specimens of high milking performance were not rare. The main use of goats was for milk and/or meat, but hair, wool and hide were also commodities. Hair and wool were dense and the hide was thick (Kukovics, 1999).

Most authors agree that the fallow goat is native to the Carpathian Basin and is likely to become extinct. In terms of horn shape, the first group of varieties are the Western European breeds (Saanen, Alpine, etc.), while the second group are the Markhor goats with twisted (corkscrew) horns. There are also specimens and breeds with horns that are bent backwards and widely spread ("prisca" horn). Hungarian goats generally have horns and long hair and are white, black, wolf or reddish coloured. They are poor performers, but their long hair and appearance corresponds to the native type. In many areas, goats with "prisca" horns can be found, mostly with long hair, but with relatively poor milk production although this is improving. The old Hungarian goat no longer exists: genes have been maintained in the fallow goats, but no distinct breed has been developed.

The main aim of this study was to evaluate Hungarian goat husbandry over the last 25 years, and summarize the current situation of goat breeding.

Materials and method

The material used for this study covered the whole Hungarian goat population. Data and information concerning changes in goat husbandry and goat breeds over the last 25 years were collected and evaluated. These data originated from the Hungarian Goat Breeders' Association (between 1999 and 2008), the Hungarian Sheep and Goat Breeders' Association (between 2009 and 2013) and the Central Office of Statistics.

Results and discussion

Challenges between 1990 and 2008

The history of imported goat breeds and Hungarian native goats has diverged since the mid 1990s when the last bulk imports of breeding livestock arrived from the Netherlands and France and the first breeding societies were organized. The Hungarian Improved Goat Breeders' Society was developed in 1994, followed by the Saanen and Alpine Goat Breeders' Society in 1995, and the Milk and Meat Goat Breeders' Society in 1996. The Saanen and Alpine Goat Breeders' Society aimed to cover all the goats originated from crossings of Saanen and Alpine bucks with Hungarian native goats. Following requests from goat keepers and breeders – along with the small societies and regional goat cooperatives that emerged from 1995 the Hungarian Goat Keepers' and Breeders' Association (or Hungarian Goat Breeders' Association) was established at the beginning of 1998.

As the predominant share of the country's goat population was not covered by any of these societies, there was no breeding programme for them to join and a new breeding programme was developed. Based on the findings of a survey, development of three breeds started in 1999: the Hungarian Milking White, the Hungarian Milking Brown and the Hungarian Milking Multicolour.

The breeding work carried out between the wars and in the first ten years after the Second World War provided the starting point for these new breeds. Three-quarters of the domestic goat population was included in these breeding projects. Over the next decades, four imported (Saanen, Alpine and Boer, Nubian) and three Hungarian goat breeds were bred, while breeding of "so-called" Hungarian improved goat stopped. The Hungarian Goat Breeders' Association had almost 1 000 full and 2 000 associated members in 2003, and covered more than three-quarters of the goat sector (almost 30 000 heads) in the country (Kukovics and Jávor, 2010).

As well as helping breeding work for farmers, the association also supported its members in the organizing the selling of kids for slaughter and purchasing goat milk. Milk processing companies were also members of the association, which helped the processors with raw milk classification, product development and promotion.

After ten years of successful activity the breeding projects of these Hungarian goat breeds were handed over to the Hungarian Sheep Breeders' Association at the end of 2008, and the milk processing firms joined the Hungarian Sheep and Goat Dairying Public Utility Association. The Hungarian Goat Breeders' Association ceased operations for administrative reasons and because it lacked resources to cover costs.

Goat husbandry today

Currently, about 40 000 does are kept for production in about 3 000 goat herds across Hungary. About 19 000 heads are officially registered of which fewer than 1 000 are in nucleus herds and are identified with conventional and electronic ear tags. Two separate recording systems function in Hungary: one under the Central Office of Statistics (COS) and the other under the Hungarian Sheep and Goat Breeders' Association (HSGBA). The COS system includes most goats in the country, while HSGBA covers only officially registered animals, that are individually tagged. Differences between the two systems are shown in Table 1. While most of the farms listed by COS keep fewer than ten heads, most larger farms (regardless of the goat products they sell) are included in the HSGBA list.

TABLE 1. DISTRIBUTION OF GOAT HERDS IN HUNGARY, 2013 (PERCENTAGES)

Herd size	HSGBA (643 farms)	COS (19 413 farms)
< 10 heads	29.7	91.9
10 –30 heads	37.8	7.6
30–50 heads	15.2	0.9
50–100 heads	11.7	0.3
100–200 heads	5.0	0.1
200–500 heads	0.6	0
> 500 heads	0	0

Breeds and production levels

Since 2009, HSGBA has had the right to carry out breeding programmes and support goat breeders. A share of Hungarian Milking White goats were sorted into the Saanen breed, and a smaller share of Hungarian Milking Brown and Hungarian Milking Multicolour goats were sorted into the Alpine breed (which in Hungary is a Chamoise-coloured, Alpine type goat). From the Hungarian goat breeds, those with long hair were selected out, and since 2010, they have been called Hungarian Indigenous (or Hungarian Native) goats; a couple of hundred of them were in the nucleus herd in 2013, and this number is increasing. Most of the goat population is still not included in any specific breed, but some goats have been described as Hungarian Native goats regardless of their phenotype or genotype.

In 2013, only 7.9 percent of Hungary's goats were in nucleus herds, and most goats (and herds) were not registered and not individually identified. In 2013, the HSGBA register counted 700 heads of Hungarian Native goats, 2 900 heads of goats belonging to exotic breeds (mainly Alpine, Saanen and some Nubians, but mainly crossbreds), and 500 heads of Boer (mainly crossbreds). The other goats, could be referred to as Hungarian Native goats, and did not belong to any nominated breeds.

Over the last couple of years, while the number of nucleus Saanen and Nubian herds (and the animals kept) decreased, the number of Alpine, Boer and Hungarian Indigenous (Hungarian Native) herds has increased. The average number of lactation days and milk yields has followed an increasing trend in most breeds, except the Nubian, in which crossbreds have become dominant and milk production has declined. The average kidding rate has fluctuated over the last five years, approaching breed standards only in Alpine, Boer and Hungarian Native goats. Average production data are summarized in Table 2.

TABLE 2. DATA ON REGISTERED NUCLEUS HERDS IN HUNGARY, BY BREED IN 2013

Breed	Farms	Adultdoes	She-goats	Kidding rate %	Lactation (days)	Lactation yield (litres)	Note
Alpine	15	251	88	171	257	685	20–25% difference among herds;
used for crossing							
Boer	8	72	42	185	-	-	Mainly crossbred
H. Native	13	350	65	165	183	318	20–35% difference among herds
Murcia G.	2	0	14	-	-	-	-
Nubian	9	258	127	159	166	240	25–30% difference among herds; mainly crossbred
Saanen	5	174	38	150	231	586	30–35% difference among herds; used for crossing

Source: Hungarian Sheep and Goat Breeders' Association.

Comparisons of the milk production levels of Hungarian Native and exotic (mainly Alpine and Saanen) goat breeds carried out by HSGBA (Table 3) found that exotic breeds were much better milk producers, although their production levels remained lower than expected.

Organization of product sales

The survey found ten small to medium-sized officially registered goat dairy factories producing various goat milk products. In addition, goat milk processing and cheese production and sales activities were being carried out on about 15–20 goat farms under varying degrees of official veterinary control; several other goat farms were selling goat products in local markets without any veterinary control. Approximately 150 kinds of goat cheese were being produced in the country.

Given the limited amount of goat milk produced on the average farm – with most goat milk processing firms operating a system of buying up goat milk. Some new investments have been made and farms with a couple of hundred milking goats have emerged with their own processing units.

TABLE 3. DATA ON AVERAGE MILK PRODUCTION IN HUNGARY

	Indigenous breed	Exotic breeds
No. of does	143	167
No. of lactation days	182.7	248.2
Lactation yield (litres)	318.3	645.2
Daily milk yield (litres)	1.78	2.60
Standardized production for 140 milked days		
Number of does	135	143
Lactation yield (litres)	266.9	418.8

Source: Hungarian Sheep and Goat Breeders' Association.

These farms apply modern technology and breeding techniques and follow new developments to keep their production profitable. Most goat populations originated from imports. As well as the large milk producing farms, new medium to large milk processing plants have also been founded to produce sufficient amounts and varieties of cheese, yoghurt, kefir, cream, etc.

The meat production of goats was utilized mainly on the farms, with only a limited share of kids being exported annually. Organized export of slaughter goats/kids ended in 2008 (Kukovics and Jávor, 2010).

Conclusions

Although goat breeding has seemed to be more organized since 2009, the number of goats in nucleus herds was still much lower in 2013 than before 2008. Most goats still do not belong to any specific breed, and most herds and animals are not registered or individually identified.

The Hungarian Sheep and Goat Dairying Public Utility Association has assisted milk production and processing, and product marketing, but organized sales of meat products (slaughter kids and adult goats) were still lacking in 2013.

The quality of breeding work should be improved and product marketing has to be developed to ensure a brighter future for goat farmers in Hungary.

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GOAT INDUSTRY DEVELOPMENT PROJECT IN ARMENIA

Narine Babayan

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Armenia is a small, mountainous, land-locked country with few natural resources. With an area of 29 800 km2, it borders Georgia, Azerbaijan, the Islamic Republic of Iran and Turkey.

Following independence in 1991, policy reforms included privatization, including of the agriculture sector. Large State farms that had dominated the sector during the Soviet period were disbanded.

The dairy industry declined and milk was consumed at the household level, with low yields and poor processing conditions. Traditional methods of animal husbandry and food processing did not meet the requirements of modern consumers.

The low yield of goat milk and the poor experience of the goat industry resulted in goats being considered merely as a type of small ruminant. Milk productivity of native breeds is a low 100 litres per 120 days of lactation, which reflects inefficient farming.

The efforts of national and international agencies towards agricultural development in Armenia led to improved livelihoods, development and economic growth in rural areas. Livestock development aimed to provide high-quality agroproducts that satisfy market demand among consumers and increase incomes at the farm level. The United States Department of Agriculture (USDA) has implemented a cattle and goat genetic improvement programme in Armenia since 2000, in close collaboration with the Armenian Agrarian University of the Ministry of Agriculture. Native breeds with special adaptive traits – such as disease resistance, climate tolerance and the ability to digest low-quality feed and survive on reduced or uncertain supplies of feed and water – are the basic material for ongoing genetic improvement projects.

Photo 1: Natine armenian goats at goat farm in Gavar (Babayan, 2014)

Photo 2: feeding practice at ARID Goat Center (Babayan, 2014)

The Goat Industry Development Project (GIDP) was launched by USDA to assist Armenian agriculture in developing independent and economically viable dairy goat production, product manufacturing and marketing through technology transfer.

Within the framework of GIDP, USDA worked with the only goat research institute in the United States of America, the E. (Kika) de la Garza American Institute for Goat Research at Langston University, Langston, Oklahoma, to develop a breeding programme for the recording, selection and multiplication of improved goat genetics. Local villagers were eager to receive cross-bred goats from Western and local Armenian varieties, and so the Armenian Improved Dairy Center (ARID) became an official breeding centre in September 2000. ARID is located in Vayots Dzor Province, Yeghegnadzor, southeastern Armenia.

Participants in GIDP are cooperatives and individual goat farms, associations, milk collection units and cheese factories, ARID's repository for improved goat genetics and its training in goat farming practices. ARID's breeding programme focuses on the genetic improvement of domestic Armenian goats through successive generation crosses to develop high-producing animals of four dairy breeds: Saanen, Alpine, Toggenburg and Nubian. With the assistance of USDA, 30 pure-bred goats were imported from the United States of America in May 2000.

The 129 pure-bred goats at the ARID centre, along with the 4 000 cross-breeds produced by 1 April 2014 in cooperating farms, are descendants of the imported goats.

Annually, more than 125 beneficiary goat farmers, cheese producers, veterinarians, extension specialists, breeding specialists, fodder producers, employees, etc. are involved in project activities, including at least 36 women and 75 rural young people.

ARID's activities within the framework of GIDP are as follows:

1. Service provision for:

- goat breeding/cross-breeding with pure-bred bucks and artificial insemination;
- herd health management through veterinary service provision;
- record-keeping and herd management.

2. On-farm research, including with the participation of scientists from the Armenian Agrarian University on:

- breeding and genetic improvement of goats;
- comparison of milk characteristics and production among native, cross-bred and pure-bred goats;
- comparison of growth and carcass characteristics among cross-bred, native and pure-bred goats.

3. Technical assistance to farmers, producers, extensionists, agribusinesses, students and young people on:

- proper nutrition, housing and care management;
- animal health and disease prevention;
- proper milking and milk handling procedures;
- grazing management;
- cooperative and financial management.

4. Training and education for farmers, producers, extensionists, students and young people via:

- seminars and workshops at the ARID centre;

- hands-on seminars and workshops in farms and villages.

5. Implementation of a youth project.

The valuable achievements of project implementation are:

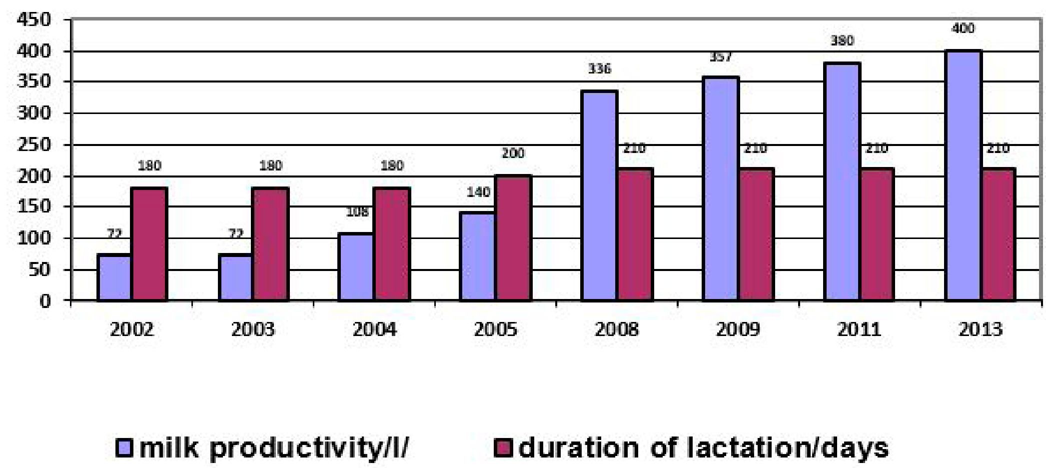
- development of goat breeding technologies;
- improved body growth through cross-breeding;
- improved and increased milk production among goat herds (Figure 1).

Table 1. shows the average daily body growth of kids recorded in the project.

TABLE 1. AVERAGE DAILY BODY GROWTH OF KIDS IN GIDP, ARMENIA

Pure-breeds	195–200 g
Cross-breeds	150–180 g
Native breeds	120–130 g

FIGURE 1. EVOLUTION OF MILK PRODUCTIVITY AT GIDP GOAT FARMS IN ARMENIA



Additional achievements are as follows:

- There is increased interest in goat farming among farmers. In 2000, two goat farmers from Vayots Dzor were involved in GIDP; in 2013, the project worked with 28 farmers.
- There are increased goat numbers throughout Armenia because the imported goats are well adapted to environmental conditions. In 1999, there were 12 000 goats in Armenia; in 2013, there were 30 500.
- There are improved milking technologies and proper milk storage facilities have been established.
- High-quality goat dairy products such as feta, tom and ricotta have been launched and an export market has been developed. In 2013, more than 100 tonnes of goat milk was processed and about 17 tonnes of high-quality goat cheeses were produced.

Photo 3: goat cheese factory at Salli village (source: Babayan, 2014)

Photo 4 and 5: cheese variestes produced at "Selim"LTD and "Golden Goat"LTD (source: Babayan 2014)

The development of small and medium-sized enterprises in the dairy sector has played a significant role in providing jobs, increasing farm incomes and improving the overall livelihoods of rural people in targeted communities.

However, to ensure the sustainability of food production and agricultural development, the market still requires expansion and improvement.

Through the improvement of farm and herd health management, and the breeding and artificial insemination programmes implemented by the ARID Goat Center, the efficiency of animal husbandry has been enhanced, but is still low. Milk yield per head is still a limitation for tens of thousands of farmers in Armenia.

There is significant need to improve grazing management and ensure the proper use of pastures and their protection from erosion. USDA's overall goals for GIDP in Armenia were poverty reduction; improvement of small farmers' operational environment; introduction of new technology to increase productivity; and improvement of farmers' living standards through the creation of opportunities and conditions for market access.

To achieve these goals, GIDP began by developing, testing and providing proven, global-quality genetics, developing and promoting economical feeding systems, and implementing disease control interventions to help increase animal productivity.

The tactics employed to achieve these general and specific objectives included establishing small dairies in villages for processing goat milk; supporting and improving traditional Armenian cheese production and developing new types of goat cheese; examining the options for direct marketing and transportation; establishing a local niche market for goat milk products; and developing an export market. In a variety of sectors, USDA worked at all levels, from the farmgate to the development of international markets.

Conclusions

The ARID Goat Center learned three valuable lessons through its involvement in GIDP's development of a viable commercial goat industry: i) with solid, upfront market research, an entire industry can be started and made to thrive in a short time; ii) using USDA's development model for Armenia – which consisted of offering an integrated package of technical, marketing and financial assistance – an agriculture sector can expand to supply new products for not only domestic but also international consumption; and iii) every link in the marketing chain, from farmgate to fork, must be developed and complete to support the shift from domestic to international marketing, and this must be accomplished by offering the latest technical assistance to committed local partners.

Photo 6: Annual contest at ARID center of youth clubs involved in goat farming (Source: Babayan, 2014)

Photo 7: Native doe and F1 kid at Rind goat farm (Babayan, 2014)

CURRENT STATUS OF THE CONSERVATION AND SUSTAINABLE BREEDING OF LOCAL AND INDIGENOUS GOAT BREEDS IN ALBANIA

Kume Kristaq,[20] Papa Lumturi[21] and Kipi Arben[22]

Abstract

Goat farming has always been considered one of the main economic activities for farming communities, especially in the hilly and mountainous regions of Albania. In the early chronicles, Albania is remembered as a country where small ruminant management has long been considered a major economic activity. The aim of this paper is to present the current situation of the conservation and breeding of local and indigenous goat breeds in the country. Currently, the breeding strategies and sustainable uses of Albanian indigenous/native/local goat breeds are developed as combinations of conservation methods with genetic improvement and sustainable development programmes. Albanian goat breeds are characterized by relatively low production levels. However, they are successfully farmed in low-input traditional and organic production systems producing a diversity of traditional products, making them a very important factor for sustainable development, especially in the hilly and mountainous regions of Albania. Various local and regional projects are being implemented for the conservation and sustainable use of indigenous/native goat breeds. These projects are part of the Albanian National Strategy and National Action Plan. Their objectives are: i) the identification, phenotypic and genetic characterization and monitoring of trends and risks; ii) strengthening of farmers' capacities for implementing breeding and conservation programmes; iii) provision of support to the development of traditional production systems on family farms; iv) promotion and support of local markets for traditional products; and v) capacity building to support biofarming and agritourism in hilly and mountainous regions.

Key words: local breed, breeding, conservation, goats

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Introduction

There is a very long tradition of goat farming in Albania. In the early chronicles, Albania is remembered as a country where small ruminant management is considered one of the main economic activities.

Goat breeding in Albania is characterized by: i) selection of breeding animals based only on farmers' empirical knowledge; ii) use of pasture according to the rules and traditional customs of communal property use; iii) reproduction based on natural mating; and iv) avoidance of inbreeding through the exchange of male animals among farmers, according to traditional rules.

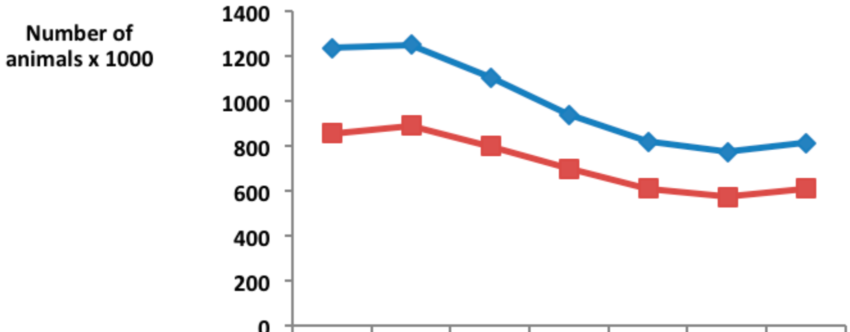
Less information on goat breed heritage is available in Albania than in other Balkan countries. This is reflected in the degree of breed characterization described later in this paper. Farmers have insufficient knowledge and understanding of the methods and needs for conserving the goat breed heritage. The Government's support for the conservation, development and sustainable use of these breeds is very small, and local goat breeds that are at risk of extinction receive only modest financial support from public funds. Far more attention and effort need to be directed to strengthening farmers' capacities for the management of sheep genetic resources and the implementation of conservation or genetic improvement programmes, establishing systems of identification and performance control, preserving and developing traditional production and processing systems for animal products, etc.

Population and production

Currently, 810 000 goats (including 614 000 dairy goats) are farmed in Albania.

Population dynamics for the period

FIGURE 1. THE DYNAMIC OF THE GOAT POPULATION IN ALBANIA



	1992	1996	2000	2005	2008	2010	2012
Total goats (in 1000)	1234	1250	1104	941	820	775	810
Milked goats	857	895	800	701	610	575	614

1992–2012 are presented in Figure 1. As shown, the goat population has decreased since 1996. This decline is also reflected in total milk production (Table 1). Since 2010, the trends in population size, and milk and meat production have increased, but by only small percentages.

Genetic variability and description

Compared with other species, the goat population of Albania has the greatest genetic variety. About 82 percent of Albanian goats can be classified in the group of Balkan goats (Kume, 1998).

TABLE 1. MILK AND MEAT PRODUCTION IN ALBANIA (THOUSAND TONNES)

Item	1992	1996	2000	2005	2008	2010	2012
Milk production	70	80	71	71	68	63	67
Meat production (live weight)[1]	30	33	35	41	43	44	48

1 Meat production from small ruminants.
Source: Statistical Yearbooks of the Ministry of Agriculture, Rural Development and Water Administration.

The rest are native breeds, classified as the ecotypes Dragobia, Velipoja, Mati, Bulqari, Caporre e Mokrres, Liqenasi Back of Dukate, Muzhake, etc. Imported Saanen and Alpine breeds and their crosses with native breeds account for about 5 percent of the total goat population (Table 2). Goats have been less exposed to pressure from exotic breeds than other farm animals have (Kume, Papa and Hajno, 2012).

Based on population size, most native goat ecotypes are at risk of extinction. Because of the lack of conservation programmes, genetic improvement and/or breeding programmes, genetic erosion of these populations is significant. Among the factors with the most negative influence is the use of uncontrolled bucks in natural insemination. Farmers' poor knowledge, information and cooperation in exchanging bucks, etc. are the most important factors for the presence of high inbreeding coefficients in native goat populations.

Albanian local goats are characterized by significant variability in colouring. Single-coloured animals (black, brown, white or reddish) and those of various colour combinations can be found. The coat is long and coarse. The males are horned, with different shapes of horn. Breeding can take place from the age of 18 months. Under intensive production systems, animals can even breed within the first year. Kidding takes place between November and March. Fertility is about 95–100 percent; prolificacy is 105–115 percent; and the milk yield varies from 80 to 250 kg, following a suckling period of 2.5–3.5 months. Kids are slaughtered just after weaning, giving a carcass weight of 8–12 kg of good-quality meat (Hajno, Kume and Dema, 1996; Bleta, Gjurgji and Mali, 2002; Kume, Bicoku and Papa, 2002).

TABLE 2. DAIRY GOAT POPULATION OF ALBANIA

Breed	Number	Trend
Local breeds or ecotypes		
Dragobi	2 950	▼ Decreasing
Has	12 500	- Stable
Velipoje	1 110	▲ Increasing
Bulqari	1 950	▼ Decreasing
Mat	12 800	- Stable
Capore e Mokrres	250	▼ Decreasing
Shyte	720	▼ Decreasing
Liqenas	3 140	▲ Increasing
Dukat	1 650	▼ Decreasing
Muzhake	62 600	- Stable
Lara e Kallmetit	830	▼ Decreasing
Native unclassified	498 100	▲ Increasing
Exotic breeds and their crosses		
Saanen	240	▲ Increasing
Crosses with Saanen	3 270	▲ Increasing
Alpine	3 860	▲ Increasing
Crosses with Alpine	7 810	▲ Increasing

Source: Technical reports of the Ministry of Rural Development and Water Administration.

Production systems

Extensive and traditional production systems are applied to the local and indigenous goat breed populations that are farmed in the hilly and mountainous regions of the country (Kume, 1998; Kume, Bicoku and Papa, 2002).

Small-scale family farm system: A few goats (one to ten animals) are kept by the family, to meet its need for goat milk, cheese and kid meat. In 2012, about 12 percent of the total goat population was kept under this system.

Extensive with transhumance: In this system, the animals are usually moved from hilly areas to nearby mountains, where they remain from early summer until October. The main products are milk for cheese making, and meat. Kids for slaughter suckle for a longer period, until they are three to four months of age. Other feeding is based on grazing, and concentrate feeds are given only at the end of gestation and in the suckling period. Kids follow their mothers to pasture at high altitudes and are slaughtered at a live weight of 15–20 kg. In this system the main objective is meat production.

Extensive without transhumance: In this production system, the goats stay in permanent installations near villages in hilly areas, and graze nearby. The products are milk and milk-fed kids, after a suckling period of three to four months.

Productive, reproductive and morphologic features

Tables 3 and 4 show data on various morphologic, productive and reproductive traits. In general, the average yields of native breeds are low. In addition, these breeds are most frequently kept in hilly and mountainous areas where the traditional system of production with low inputs is dominant (Kume, Bicoku and Papa, 2002).

The most traditional products made from goat milk are different type of cheese, such as Teleme, Vize and Kasher. Most of these cheeses are produced from mixed milk (goat, cow and sheep milk). Cheese derived from only goat milk is produced in only a few milk-processing units. The lack of policies to support traditional production, and the current situation regarding food imports (conditions of participation in the World Trade Organization) are the most important factors in limiting sales of these products to domestic markets, although the quality of traditional products is generally good. In addition, although goat dairy products in Albania are almost all bioproducts, the insufficient service control for food quality and safety, the low standard of veterinary services, and the lack of legal infrastructure and investments for creating the conditions for milk production and processing in accordance with European Union regulations, do not allow these products to be sold on international markets.

TABLE 3. MORPHOLOGIC TRAITS OF ALBANIAN LOCAL GOAT ECOTYPES/BREEDS*

Ecotype/ breed	Body length	Wither height	Heart girth	Tibia circum-ference	Udder circum-ference	Teat length
Hasi	69.8 ± 1.1	67.4 ± 0.7	80.3 ± 1.0	8.5 ± 0.09	33.5 ± 0.12	3.9 ± 0.09
Dragobia	72.4 ± 2.2	68.9 ± 1.1	84.7 ± 0.7	8.9 ± 0.07	37.3 ± 0.13	4.2 ± 0.14
Skuqe e Matit	74.1 ± 2.6	69.1 ± 2.0	86.8 ± 0.9	7.8 ± 0.09	37.8 ± 0.18	3.8 ± 0.09
Velipoja	77.4 ± 1.3	68.6 ± 0.8	87.2 ± 1.2	9.2 ± 0.13	39.6 ± 0.12	4.1 ± 0.01
Bulqari	72.4 ± 2.3	68.4 ± 0.9	85.2 ± 1.2	8.6 ± 0.14	38.6 ± 0.16	3.9 ± 0.06
Lara e Kall-metit	76.9 ± 2.4	70.1 ± 0.6	86.8 ± 1.6	7.7 ± 0.11	37.1 ± 0.19	4.3 ± 0.07
Caporre e Mokrres	65.4 ± 2.3	61.8 ± 1.0	81.2 ± 0.7	6.9 ± 0.04	36.8 ± 0.14	3.6 ± 0.11
Liqenas	65.1 ± 2.2	66.2 ± 1.1	78.3 ± 0.9	7.2 ± 0.06	33.6 ± 0.16	3.7 ± 0.08
E zeza e Dukati	62.5 ± 2.7	56.8 ± 0.8	72.6 ± 1.0	6.4 ± 0.09	30.6 ± 0.16	3.3 ± 0.08
Muzhake	64.8 ± 2.1	61.1 ± 0.7	75.8 ± 0.8	7.2 ± 0.04	31.2 ± 0.15	3.6 ± 0.06
Unclassified	63.8 ± 2.2	58.9 ± 0.9	73.8 ± 1.2	7.0 ± 0.06	32.7 ± 0.17	3.5 ± 0.04

*Estimated data.

TABLE 4. PRODUCTION AND REPRODUCTION TRAITS OF ALBANIAN LOCAL GOAT ECOTYPES/BREEDS*

Ecotype/ breed	Live weight (kg)		Milk (kg/lac-tation)	Milking days	Fertility %	Live birth weight (kg)		Live weaning weight (kg)	
	M	F				M	F	M	F
Dragobi	84.2 ± 2.6	65.4 ± 2.1	124.4 ± 6.1	155	97	2.7 ± 0.3	2.2 ± 0.1	16.3 ± 0.2	15.2 ± 0.2
Has	82.8 ± 3.1	56.2 ± 2.4	165.2 ± 5.3	176	95–105	3.6 ± 0.2	2.7 ± 0.1	16.2 ± 0.1	15.1 ± 0.3
Velipoje	68.7 ± 2.8	48.6 ± 2.1	179.1 ± 5.7	192	100	2.7 ± 0.2	2.5 ± 0.2	13.2 ± 0.1	12.6 ± 0.3
Bulqari	75.5 ± 3.5	53.2 ± 2.8	164.3 ± 4.3	184	100	2.8 ± 0.1	2.4 ± 0.2	14.4 ± 0.3	12.9 ± 0.1
Mat	74.1 ± 2.8	54.6 ± 3.5	147.2 ± 3.2	178	98–100	3.2 ± 0.1	2.9 ± 0.2	15.2 ± 0.3	13.4 ± 0.1
Capore e Mokrres	68.4 ± 2.9	1.2 ± 2.7	212.5 ± 6.8	190	95	1.8 ± 0.3	1.6 ± 0.1	11.5 ± 0.2	9.3 ± 0.0
Shyte	63.7 ± 3.1	48.6 ± 4.1	208.3 ± 5.1	185	95	1.8 ± 0.2	1.6 ± 0.2	10.6 ± 0.2	8.7 ± 0.1
Liqenas	58.3 ± 2.9	43.2 ± 3.4	140.3 ± 4.2	184	98	2.3 ± 0.3	1.9 ± 0.2	15.1 ± 0.1	12.3 ± 0.2
Dukat	51.4 ± 3.2	36.7 ± 3.1	83.4 ± 4.7	154	90	1.5 ± 0.1	1.3 ± 0.1	11.5 ± 0.1	10.7 ± 0.2
Muzhake	52.6 ± 4.1	2.1 ± 3.3	136.1 ± 6.2	170	95	2.2 ± 0.1	1.9 ± 0.1	16.4 ± 0.3	14.5 ± 0.3
Lara e Kallmetit	89.2 ± 2.1	2.3 ± 4.1	169.5 ± 5.3	169	90–95	3.3 ± 0.2	2.5 ± 0.2	18.3 ± 0.3	14.3 ± 0.2
Unclassified	65.3 ± 4.6	46.3 ± 5.2	115.2 ± 6.4	178	95	2.1 ± 0.2	1.8 ± 0.3	12.4 ± 0.1	10.8 ± 0.1

*Estimated data.

Programmes for the conservation and sustainable use of local goat populations

Programmes for the conservation of native/indigenous ecotypes/local goat populations in Albania have been designed and implemented since 2007. The framework of these programmes includes measures for conserving breeds/ecotypes/populations at risk of extinction. The National Action Plan has been updated in line with the strategic priorities for action in FAO's Global Plan of Action for Animal Genetic Resources (FAO, 2007). For native/indigenous goat populations in Albania, the National Action Plan provides two main directions of work:

1. Identification, phenotypic and genetic characterization and monitoring of trends and risks;
2. Conservation, sustainable economic use and development of breeds/ecotypes/populations.

To implement programmes and projects, international donors such as the Global Environmental Facility, the United Nations Development Programme and the United States

Agency for International Development, and public funds from the Ministry of Agriculture, Rural Development and Water Management, the Public Agency for Research and Innovation and the Ministry of Education and Sport are activated.

The law on livestock breeding approved in October 2008 is the main development in legal legislation for the conservation and use of animal genetic resources in Albania. According to this law, the Government is responsible for taking measures to protect indigenous breeds that are at risk of extinction.

In the National Action Plan, three main directions are identified for protecting and managing native/indigenous goat populations more effectively:

1. Sustainable development of commercial farms – medium- and high-input production systems. Policies for this development focus on encouraging and supporting private initiatives. Currently, there are several large farms where local breeds and/or crosses with Alpine goats are farmed under intensive production systems (Kume, Papa and Hajno, 2012).

2. Sustainable development of farms breeding goats under the low-input and traditional production system. The use of local sources, such as local/native/indigenous animals breeds and the spontaneous flora of meadows, pastures, forests, etc., and traditional techniques for animal breeding and exploitation of environmental capacities are part of Albanian farmers' traditional practices. The traditional production system depends on the efficient and sustainable use of agrobiological diversity. The Government's requirement for promoting sustainable development of this diversity demonstrates the priority given to this system (Dedej, 2006).

Capacity building to support family farms and traditional production systems is an important objective of the National Action Plan. In northern and northeastern Albania, the implementation of projects with these objectives has started.

3. Development of biofarming systems. Capacity building to support biofarming and the creation of local markets for biofarm-labelled products are medium-term objectives in the National Strategy for Sustainable Rural Development.

Implementation of a subsidy system has started. Farms that are breeding local/indigenous goats under the traditional production system and that are certified as biofarms are the potential beneficiaries.

Conservation programmes

Under the Albanian National Action Plan for Farm Animal Genetic Resources, the first action is the identification and phenotypic and genotypic characterization of native/indigenous goat breeds. Research on the genetic characterization of Albanian goat breeds, and evaluation of the distances among different Albanian breeds and between them and other regional breeds have been carried out. In Albania, two scientific groups are responsible for this field of research. These groups have carried out research to evaluate polymorphism at the desoxyribonucleic acid (DNA) level and the genetic distances among different native/indigenous goat breeds (Hykaj, Hoda and Papa, 2012). However, the results of identification, characterization and management of these animal genetic resources are still not enough. The factors with the greatest negative effects are, on the one hand, the limited financial resources for implementation of the National Action Plan and the limited opportunities for subsidizing goat breeds at risk of extinction and, on the other hand, the lack of genetic and/or breeding programmes and the infrastructure necessary for their implementation..

In-situ conservation programmes

Description of the Velipoja goat ecotype: Medium-sized animals with very developed and harmonic skeleton, chest girth 80–91 cm, diagonal length 72–82 cm, shin girth 9–10 cm, teat length 6.2–7.8 cm, long head, bulging eyes, backwards leaning horns that are thin at the end, red and black-coloured mantle.

Beard and wattle are present. Ears are medium sized.

Photo 1: Velipolja goat (Source: Kristaq Kume, 2014)

Objectives

- Developing a Velipoja goat breeders' association as a voluntary union of farmers to be responsible for the implementation of in-situ conservation programmes: 15 farmers, 500–600 animals.
- Application of economic mechanisms to enable implementation of milk collection and processing schemes.
- Establishment of local, village-based centres for milk processing to produce local products labelled "Cheese of Velipoja goat".

Description of the Caporre e Mokrrës goat breed: Small-sized body, arched nasal profile of males, straight nasal profile of females. Males have arched horns, females are without horns. Both females and males have a tassel of wool on their fronts. Neck is short and slightly muscular. Abdomen is rounded and slightly voluminous. Well-developed and rounded udder. White to reddish-coloured fleece. Wool covers all body, neck, basal part of head and tale. Length of hair is 40–45cm, shorter over ribs and abdomen. Hair of the face is of brick-red colour. Some animals have brick-red-coloured extremities.

Photo 2: Caporre e Mokrrës goat (Source: Kristaq Kume, 2014)

Objectives: Selection of a new generation of males and females to serve as reproducers. Establishment of 10–15 lines of male reproducers for a five-year period.

Steps of the in-situ conservation programme are:

1. Selection of target farms according to the criterion of size of herds – those with at least 20–30 goats;
2. Selection of goats and bucks that markedly express phenotypic characteristics of the breed;
3. Earmarking of animals, establishment of herd book;
4. Compilation and implementation of controlled natural matching scheme;
5. Compilation and implementation of the Veterinarian Protocol.

Ex-situ conservation

Establishment of national cryobank for somatic cell conservation: Although there are facilities in Albania that could be used for the collection and freezing of goat semen, no practical collections are currently being made. Establishment of a cryobank where samples of bucks' semen could be conserved is, therefore very difficult. A possible solution would be the establishment of a cryobank of somatic cells.

Activities:

- identification of indigenous/native/local goat populations that are at risk of extinction;
- selection of animals with fully and clearly expressed characteristics of the respective indigenous/native breed and/or local goat population;
- sampling of somatic cells – i.e. tissue, blood;
- addressing of legal issues to facilitate establishment of a cryoconservation bank.

National genebank for ex-situ, in-vivo conservation:

Activities:

- identification of indigenous/native/local goat populations at risk of extinction;
- capacity building to support establishment of the necessary infrastructure for breeding animals for herd collection;
- compilation and implementation of genetic programmes for ex-situ, in-vivo conservation.

Currently, two native sheep breeds – Shkodrane and Lara e Polisit – are being bred in an ex-situ, in-vivo genebank (Cili, Caca and Toska, 2013).

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RELATIONSHIPS OF GOAT BREEDING AND FARMING WITH ENVIRONMENTAL PROTECTION AND CONSERVATION

Ivan Kyssa,[23] Anna Shulga,[23] Dmitry Krylov[24] and Tatiana Sergienia[25]

Abstract

This article discusses the current state of and prospects for the development of goat breeding in Belarus, and the main directions for improving the economic efficiency of milk production in the future.

Key words: dairy cattle, goat breeding, smallholder farm

Introduction

Belarus positions itself as an agrarian country, so agriculture accounts for a significant share of gross domestic product (GDP). Maintaining competitiveness is impossible without considerable scientific research, use of the world's leading innovations, and continuous improvement and optimization of the technologies used.

Discussion

Dairy cattle is the most important livestock industry in Belarus. Goat breeding has never been popular, although during the Soviet period there were several large farms breeding goats. According to statistics, the number of goats in Belarus has been relatively stable over the last 50 years, varying from 55 000 to 75 000.

Like the productive livestock industry, goat breeding provides the economy with valuable products. Like sheep breeding, it has several products: unique industrial raw materials –wool (mohair) and goatskin; and food – milk and meat.

A side-feature of production is goat manure, which is one of the best fertilizers for gardens. Its effects surpass those of cow or horse manure. Goat manure is especially

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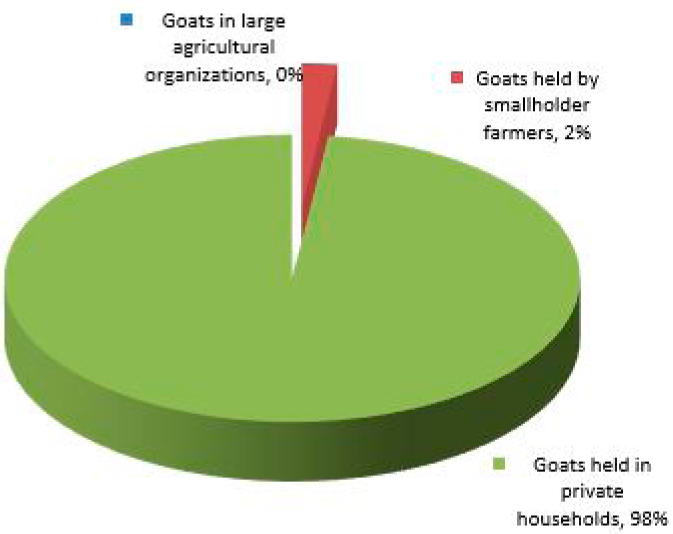
suitable for greenhouses and hothouses; requirements for goat manure are a fifth of those for cow manure and a quarter of those for horse manure. One goat housed on bedding during the stall period provides 350–500 kg of manure.

Goat milk has curative and preventive qualities, so in the last decade people's interest in dairy goats has increased in Belarus. The milk's physical and chemical properties and taste compare favourably with the milk of other animals. The chemical composition and properties of some goat milk are similar to those of cow milk, but goat milk is richer in calories and has higher contents of dry solids, fat, protein and minerals. It is whiter than cow milk.

Currently, Belarus has about 67 000 goats in backyards and about 1 300 on smallholder farms housing about two dozen goats each.

Figure 2 shows the distribution of livestock on goat farms of all categories.

FIGURE 2. DISTRIBUTION OF GOATS ON FARMS OF ALL CATEGORIES IN BELARUS



As shown in Figure 2, large agricultural organizations in Belarus are not involved in goat breeding, and goat breeding on farms is at an early stage of development. The largest smallholder farm engaged in goat breeding is DAK farm.

DAK farm is located in Dzerzhinsk district, 20 km southwest of Minsk. The farm is owned by the family of Dmitry Krylov and Galina Vauchaninoy, who have a staff of six to nine employees, depending on the season.

DAK farm was founded in 1992. Initially, the government granted 10 ha of land, but since then the farm has expanded three times, and currently covers 100 ha of farmland.

Over the years, good results have been obtained: the dairy herd of 295 goats is the largest in Belarus; the farm regularly takes part in agricultural shows and has the official status of a breeding farm; and every year it produces 120 tonnes of goat milk.

Currently, DAK farm collaborates with the International Public Association of Animal Breeders (IPAAB) East-West, with the aim of converting from traditional to organic agriculture. A significant achievement in the 2012 season was the farm's first audit for certification of production in accordance with Council Regulations 834/2007 and 889/2008. Experts from IPAAB East-West prepared the necessary documents for record-keeping in organic production, developed a conversion plan and contracted the certification body Organic Standard Ltd from Ukraine.

Under the conversion plan, the farmers invested in the construction of a milk processing unit capable of producing a wide range of products from goat milk (milk, yoghurt, sour cream, cottage cheese and various types of mozzarella and ashard cheese). According to the conversion plan, the farm was to be completely converted by the end of 2014 as the first farm in Belarus with farm-based, small-scale organic milk processing.

A significant problem for goat breeders in Belarus is the challenge of processing products. Currently, goat milk is processed only at the Slutsk cheese-making plant and at Bellakt in Volkovysk. The Slutsk cheese-making plant has managed to reach production of 3 tonnes/month. Milk is purchased from farmers or private traders, and pasteurized, filtered and bottled. The production line is designed to process 300 litres/day, but goat milk is processed only three times a week.

At Bellakt in Volkovysk, goat milk is processed with the same frequency. The low demand for goat milk, coupled with the need to purchase and install additional equipment for its processing, inhibits development in this area. Bellakt processes about 60 tonnes of goat milk per year, buying it from four farmers throughout Belarus (from Grodno to Gomel regions).

Another problem is that there are no large farms breeding dairy goats in the country, so the priority issue is the acquisition of breeding animals. Weak stock breeding work, where it is difficult to avoid animal inbreeding, leads to breed degeneration. Success of the dairy goat depends largely on the possibilities for acquiring breeding animals abroad, contacting goat breeders from different countries, developing internal connections for the production and sales of products, and obtaining support from government agencies.

Belarus has goats of mainly dairy breeds, including Saanen, Toggenburgen, White Russian, Gorky and improved local breeds. The Saanen goat is considered the best breed for milk yield. Pure-bred Saanen goats were first imported into Belarus in the late 1980s for three public collective farms: Voykov Minsky and Progress in Grodno, and Politotdelets in Lepel district.

A considerable part of the offspring of these goats has been utilized. Unfortunately, all of these facilities eliminated their goat herds in the early 1990s, for various reasons.

Saanen goats have the highest live weights of any goat in the world. Adult females are 75–77 cm high at the withers, and their live weight averages 50–60 kg; adult males weigh 80–90 kg. Saanen goats are characterized by high fertility and precocity. The reproduction rate is from 180 to 250 kids per 100 females. The lactation period lasts for ten to eleven months, during which a dam gives an average of 600–700 kg of milk. Average fat content is 3.8–4.5 percent (Lebedko et al., 2010).

Saanen goats are well adapted to different climate zones. When they are crossed with other breeds, they steadily transmit their economically useful qualities to offspring.

Like Saanen, Toggenburgen goats are also bred in Switzerland. The live weight and size of Toggenburgen goats are inferior to those of Saanen. The height of does is 70–75 cm, with live weight not exceeding 45–55 kg; adult males weigh 60–70 kg. Toggenburgen goats have similar fertility to that of Saanen goats. Milking of Toggenburgen goats produces 400–1 000 litres/doe/lactation. The average fat content is about 4 percent (Lebedko et al., 2010).

Russian White breed goats were imported to Belarus from central and northwest regions of the Russian Federation. These goats have good milk production. For eight months of lactation under normal maintenance conditions, Russian White goats give 350–500 litres of milk; fat content is 4–5 percent. Russian White goats can be valuable improvers of local breeds (Lebedko et al., 2010).

In some areas of Belarus, there are Gorky dairy goats; this breed is based on the improvement of local goats through cross-breeding with Saanen goats. Gorky goats are mainly white, with short wool and little downy undercoat. The males' live weight is 50–60 kg; that of does is 38–42 kg. Milk yield per nine- to ten-month lactation period is about 450–500 litres; fat content is about 4.2–5.2 percent. Reproduction is up to 190 kids per 100 females (Lebedko et al., 2010).

Because for many years goats have been bred on only small farms where breeding work is almost non-existent, most goat farmers have local dairy goats of different breed lines that were previously imported to Belarus.

Features of local dairy goats are their need for only simple housing and their good adaptation to local climate conditions. Local dairy goats are heterogeneous: they vary in size, colour and other characteristics. Adult females of local dairy goats weigh 38–45 kg, occasionally reaching 50 kg; adult males weigh about 50–60 kg. During the six to eight months of lactation, does give about 300–400 kg of milk; fat content is about 4–4.2 percent. The reproduction rate is about 150–180 kids per 100 females.

Various research activities, scientific training and skills development in animal husbandry are carried out in Belarus to increase the efficiency of goat breeding. The purpose of research is to:

- improve the goats bred in Belarus and develop new breeds, types and lines;

- develop new kinds of compound feed and feed additives based on local sources of raw materials;

- improve feeding, housing and the use of animal technologies.

Conclusions

Dairy goat breeding has good prospects for development in Belarus. Its development is hampered by lack of adequate specialized dairy breeds, domestic equipment for animal maintenance and milking, processing capacity for small batches of goat milk, and cooperation in the marketing of raw materials.

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GEORGIAN LOCAL GOAT BREEDS AND BRUCELLOSIS INFECTION

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Abstract

Georgia is located in the Caucasus region and is geographically divided into eastern and western parts with two separate types of local goat breed: the eastern type are kept in nomadic husbandry systems, have an average live weight of 35 kg, and average milk production of 150 kg/year; the western type are kept in free-roaming husbandry systems and have average live weights of 38–40 kg for females and 60–80 kg for males. Lactation lasts 210–230 days, with average milk production of 500–700 kg/doe. The reproduction rate averages 1.4–1.5 kids/doe. Goat and sheep meat and milk products are substantial sources of protein for the rural population of Georgia. Based on historical observation, the main problem concerning sheep and goat health is brucellosis. A prevalence study was conducted to determine the "hot-spots" for brucellosis among small ruminants (sheep and goats). Based on the survey results, some villages in Georgia exceed 10 percent prevalence of brucellosis among small ruminants, including goats. Most of these villages are located in regions that practise nomadic pastoralism of small ruminants.

Key words: goat, brucellosis, prevalence, nomadic

Introduction

Georgia is located in the Caucasus region, bordering the Russian Federation, Turkey, Armenia and Azerbaijan. It has a territory of 69 700 km2, of which more than 66 percent is mountainous. Geographically, the country is divided into eastern and western parts. The small ruminant population of Georgia is about 700 000 sheep and 70 000 goats (Table 1). No identification/registration system is in place. The goat population includes two types of Georgian local breed: the western type, and the eastern (Megrelian) type.

Goats of the eastern type are kept in nomadic husbandry systems, and travel with sheep to summer/winter pastures. Average live weight is 35 kg (maximum 50 kg); height is 64 cm; and average milk production is a low 150 kg/year.

Goats of the western type are kept in free-roaming husbandry systems on pastures near villages, separately from sheep. Live weight of adult females averages 38–40 kg and that of males, 60–80 kg. Lactation lasts 210–230 days, with average milk production of

500–700 kg/doe. The reproduction rate averages 1.4–1.5 kids/doe: 50 percent of kids are single, 46.5 percent are twins and 3.5 percent are triplets. Photos 1 and 2 show western goat types.

Photos 1 and 2. Western Georgian types of goat breed (Source: Lasha Avaliani, 2014)

Based on historical observation of laboratory records between 2007 and 2011, the main problem concerning small ruminant health is brucellosis. A country-wide prevalence study was conducted to determine the hot-spots for brucellosis among small ruminants (sheep and goats).

Materials and method

Blood samples were randomly collected in all regions of Georgia. The unit of interest was the village, where animals are treated as a homogeneous population.

The epidemiological method used was the "presence or absence" calculator from Cannon (2001) to determine the number of villages and animals to be investigated and to ensure that they represented villages and animals across the country. In all cases, the following statistical parameters were considered in estimation of the required sample size:

- required confidence level: 95 percent;
- sensitivity of rose bengal test: 95 percent;
- expected prevalence: 10 percent.

A village with at least one seropositive result was considered positive for brucellosis and assumed to have at least 10 percent prevalence of the disease. If no animals tested positive, it was understood that the village had less than 10 percent prevalence. Clotted blood samples were taken randomly, stored in cold boxes and delivered to the laboratory within 48 hours.

In total, 7 798 small ruminant samples were screened using the rose bengal card test and confirmed by fluorescence polarization assay.

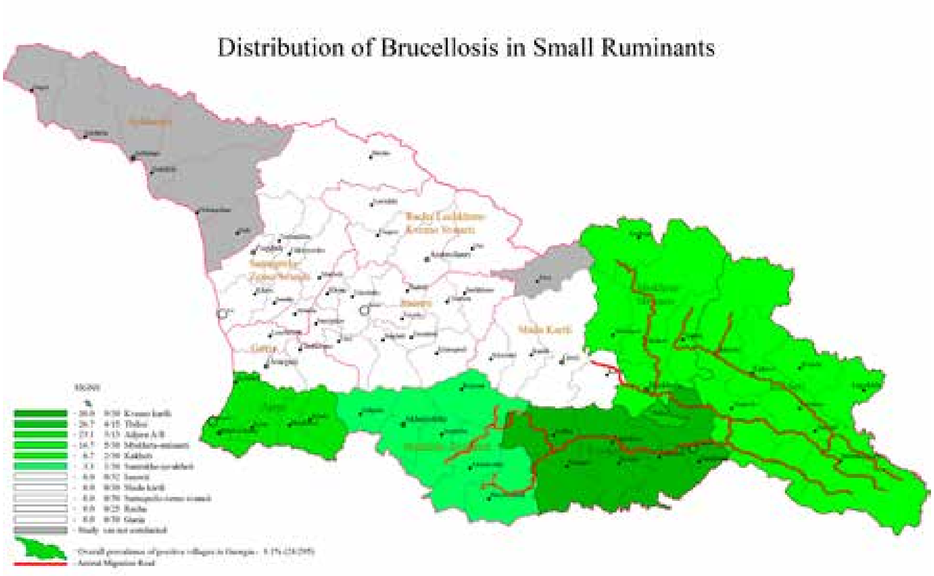
Results

Based on the survey, brucellosis in small ruminants is unevenly spread across the regions of Georgia and its prevalence is equal to or surpasses 10 percent in several villages (Table 1). The majority of positive villages are located in regions and districts where there are seasonal migration roads (Figure 1).

TABLE 1. BRUCELLOSIS-POSITIVE VILLAGES IN GEORGIA

Region	Sheep	Goats	Total villages	Villages sampled	Positive villages	Positive villages (%)
Samtsk-he-Javak-heti	90 000	5 000	108	30	1	3.3
Shida Qartli	30 000	4 000	150	30	0	0
Kakheti	400 000	20 000	167	30	2	6.7
Qvemo Qartli	150 000	10 000	241	30	9	30
Mtskhe-ta-Mtianeti	15 000	2 000	305	30	5	16.7
Imereti	6 000	12 000	388	32	0	0
Racha-Lech-khumi	100	500	52	25	0	0
Samegrelo	800	12 000	110	30	0	0
Guria	100	3 000	94	30	0	0
Adjara	200	1 000	13	13	3	23.1
Tbilisi	400	300	22	15	4	26.7
Total	692 600	69 800	1 650	295	24	8.1

FIGURE 1. DISTRIBUTION OF BRUCELLOSIS IN SMALL RUMINANTS IN GEORGIA



Discussion

High-dissemination areas include Tbilisi, regions where there are animal migration routes and populations follow nomadic pastoralism in Kvemo Kartli, Adjara, Mtskheta-Mtianeti regions. It is noteworthy that in Adjara region, where the number of ruminants is very low, the level of disease is a high 23 percent. There is need to collect further information on this matter.

Based on survey results, it can be assumed that high-risk areas for brucellosis are those where populations follow nomadic pastoralism. Such regions are Kakheti, Kvemo Kartli, Samtskhe-Javakheti, Mtkheta-Mtianeti, Adjara and Guria (Ozurgeti Municipality). Cattle and small ruminant migration to summer and winter pastures occurs through these regions. In all of them except Guria, the disease is present in both cattle and small ruminants.

Regarding Tbilisi, a change in administrative borders led to expansion of the capital city territories to include a number of villages in Mtskheta-Mtianeti and Kvemo Kartli.

According to the survey results, some villages showed 0 percent animal disease; this does not necessarily mean that the region is free of disease, but rather that prevalence of the disease is probably less than 10 percent.

Conclusions

Nomadic pastoralism and different ways of keeping animals, diseases that are developing without symptoms, owners' negligence in failing to carry out systematic examination of livestock, and low awareness of diseases are major causes of disease spread, especially in the historically affected areas of Georgia. Other factors contributing to disease spread include unrecorded sales of animals from one village or region to another without health checks and controls; slaughtering of livestock at home for private consumption; and keeping healthy animals with aborted or diseased ones.

Acknowledgements

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Dr Vasil Gligvashvili

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THE DOMESTIC LIVESTOCK RESOURCES OF THE REPUBLIC OF MOLDOVA: GOAT AND SHEEP BREEDS

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Ministry of Agriculture and Food Industry of the Republic of Moldova

Abstract

In the Republic of Moldova, farms – particularly goat and sheep farms – are small, keep few animals and provide only minimal inputs. The country's goat and sheep population was 852 000 heads in 2013, down from 15 million in 1996 but still representing an important livelihood asset for smallholder farmers. The Republic of Moldova is still on the road to development. Livestock production is an important economic activity, but production remains inadequate to supply the nutritional requirements of the population. To increase livestock production, in the last three years, Saanen and French Alpine goat breeds have been imported and are currently being kept under an acclimatization research programme. However, native goats are generally well adapted to the natural environment, the local inadequate and unbalanced nutrition situation and disease stresses. Efforts should be continued to characterize and improve the productive traits of native goats alongside the use of exotic breeds, which have potentially superior productivity but lower adaptability. The government, research institutions and producers should work together to ensure that local goat and sheep genetic resources are preserved and can thus continue to contribute to biodiversity and sustainable livestock production.

Key words: biodiversity, conservation, goat and sheep breeds, production system

Introduction

Agriculture has changed in the twenty-first century and is now not just about producing food, but has many other functions. By becoming more responsible for the environment and strengthening relationships with rural areas, agriculture has assumed social roles besides its economic ones. Even its primary production function has changed and the focus is now on offering a safe and diverse selection of food and other products. The twenty-first century has also brought new challenges such as price volatility, climate change and rural poverty, which agriculture should seek to address. Figure 1 illustrates the changing role of agriculture.

Over the last decade, development of the livestock sector has been driven by market competition and other market-related bottlenecks (Figure 2). The livestock sector faces domestic resource constraints (limited feed supply) and heavy pressure from cheaper livestock imports. Domestic feed supply is short because of the limited availability of good-quality pastures, which is, in turn, the result of unfavourable weather conditions and limited irrigation capacity. At the same time, the relatively high domestic costs of production, low productivity and poor breeding stock make it difficult for Moldovan livestock products to compete with cheap subsidized meat and dairy products arriving from the European Union and the Commonwealth of Independent States. As a result, the country is a net importer of most livestock products.

Results and discussions

The structure of the Republic of Moldova's livestock is 31 percent cattle, 31 percent pigs, 6 percent sheep and goats, 29 percent poultry and 3 percent other animals.

Animal husbandry in the country is practised predominantly by farming associations and private household farms, which account for the majority of livestock production: milk (97 percent), cattle and poultry (72.7 percent), and eggs (65.7 percent). The private sector holds 94 percent of cattle (including 97 percent of cows), 72 percent of pigs and 98 percent of sheep and goats.

The livestock sector in the Republic of Moldova is undergoing a transition to new technologies in animal exploitation, selection methods and performance improvement. The sector's shift towards a market economy has underlined weaknesses in the genetic stock of animals kept in former state and collective farms.

Among the branches of the livestock sector, sheep and goat breeding have followed a distinct path of change and transformation. During the reforms, the total sheep and goat herd has not declined and remains about 850 000 heads, while the number of goats has practically doubled, to reach more than 100 000 heads.

As a result of changes in livestock farming, the sheep herds of collective agricultural enterprises have been privatized and are now almost entirely owned by private enterprises, homesteads, sole proprietors and households.

Following more than two decades of reforms and transformation, the situation of sheep and goat breeding farms has changed significantly. In 1996, two herd queen bee breeding farms of the Tsigai breed had about 15 300 sheep and 10 000 goats (or about

25 000 in total); in 2007, only one breeding farm of Tsigai breed with a queen bee population of 2 234 goats, and two farms with a total of 1 450 goats (making 3 684 heads altogether) were found. In 2010, three breeding farms with a total of 2 244 heads of Ţsigai breed, and three farms with 1 472 Karakul breed animals (making 3 716 heads altogether) were certified.

In 2013, the introduction of state subsidies for the purchase of pure-bred sheep and goats – of 100 lei/kg body weight – substantially increased farmers' interest in establishing breeding farms through the acquisition of genetic material from both other farms in the country and imports. In 2013, two goat and 14 sheep farms applied for accreditation as breeding farms.

Moldovan sheep and goat breeds

Moldovan Tsigai sheep breed for meat, wool and milk: This breed was created by crossing indigenous Tsigai (wool/milk) animals with male Crimea (wool/meat) and Priazov (meat/wool) animals.

The Moldovan Tsigai breed is characterized by increased body mass and wool production. Elite-class breeding rams have a body weight of 80–100 kg and produce 7.0–9.0 kg of wool. Ewes in this class weigh 50–60 kg and produce 4.7–5.2 kg of raw wool. Prolificacy is 118–123 lambs per 100 ewes. Lambs have the growth characteristics of dual-producing sheep breeds and ewes have good lamb feeding characteristics. Average milk production is 126.3 kg per 180-day lactation period.

A significant proportion of sheep of this breed produce 200 kg of milk or more, allowing selection and breed improvement through the use of hybrids derived from ewes with high milk production.

Moldovan Karakul breed: This breed type was created by crossing indigenous Tsushca sheep with Asian breeds imported mainly from Uzbekistan in the 1970s and 1980s. Several generations of this breed have been raised and now reproduce descendants that produce Karakul lambskin and have high body weight and good milk production. These sheep therefore have good characteristics for producing skins, meat and milk. Animals of this breed are robust with well-balanced bodies, long heads with a convex profile and large fat deposits in the buttocks. Body weights average 90–100 kg for breeding rams and 50–55 kg for ewes. Most sheep are without horns.

Ewes produce at least 70–80 kg of milk per lactation period of 140–160 days, depending on the breed selection and nutrition. Prolificacy is about 105 percent. Newborn lambs are stout, and at six months of age, rams weigh 35–40 kg and ewes 28–35 kg; while at 18 months, with good nutrition, rams reach 50–60 kg and ewes 40–45 kg. Approximately 47 percent are slaughtered at 6–7 months of age.

Skins obtained from Karakul sheep are large and of curly type. Most are black or grey in colour.

Local goats: Local goat breeds are medium-sized or small with the general appearance of milk producing goats; the head is medium sized; the neck thin and relatively long; the thorax narrow or of medium width and depth; the abdomen bulky; the backs and shoulders straight, of medium length and width, with a narrow to sturdy ribcage; and the skin is thin and elastic. Both males and females may have horns. Hair varies in colour and can be white, black, grey, various shades of brown, or black; the hair of some animals is of several colours. Milk production and body weight vary depending on the conditions during the animal's early development, increasing with the level of nutrition. Milk production is 100–500 kg or more per 210–270 days of lactation; the body weight of adult goats is 35–60 kg. Prolificacy varies from 125 to 180 percent, depending on the herd.

Imported goat breads

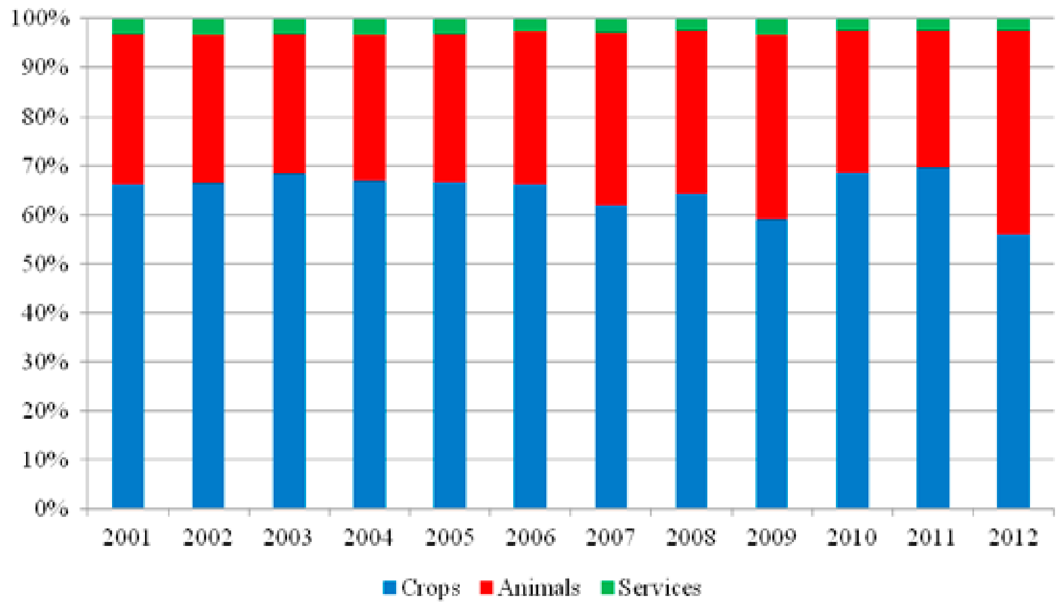
Saanen: Animals of this type have a high waists, medium-sized heads, long necks, broad and deep thoraxes, voluminous abdomens (in males), straight backs and shoulders, long, wide and well-developed frames, thin, elastic skin, and fine, white hair that is smooth and shiny with no visible down. The skin on the face, ears and udder (or scrotum) is often marked with black spots. The udder is large, bulky, elastic, smooth and round or pear-shaped, with lobes growing evenly and sufficiently large nipples. The legs are straight and strong. Body weight in adult goats is 50–60 kg for females and 80–100 kg for males. Milk production is 600–1 000 kg or more per lactation of 270–300 days.

French-Alpine: Animals of this breed have relatively small heads, long necks, broad and deep thoraxes, voluminous abdomens, straight, long backs with shoulders of medium width, strong frames, thin, elastic skins and hair colours that range from light tan (red) to dark brown almost black. Most animals have a line of darker hair along their spines, and darker hair on the front of their skulls and muzzles. Some have white patches on their flanks or heads. The outer hair is fine and glossy, without clearly visible down. The udder is glandular, voluminous, elastic, smooth and round, with large or medium-sized nipples.

Challenges

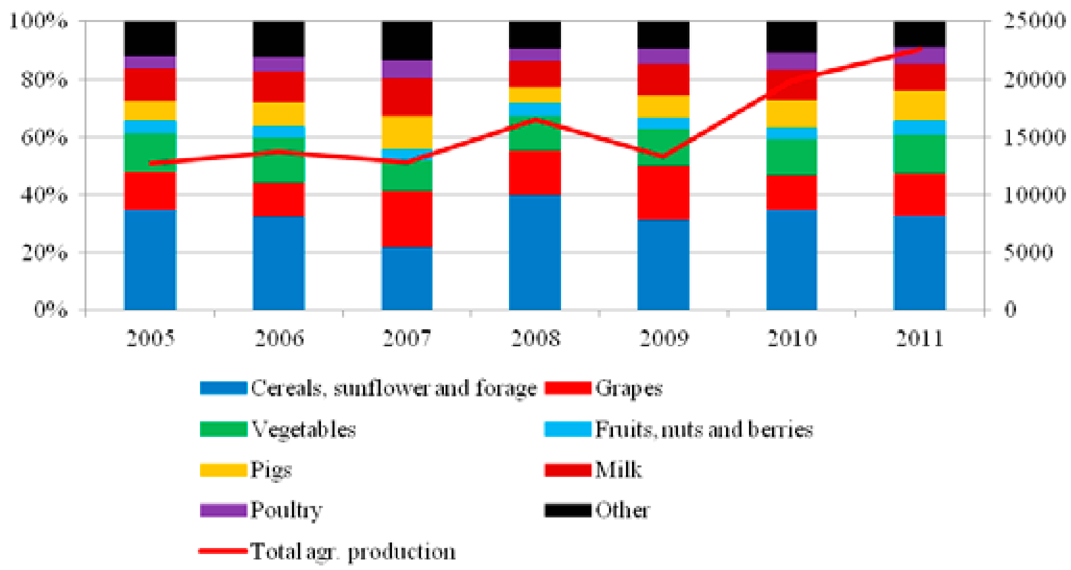
Of the country's 850 000 heads of sheep and goats, about 700 000 are sheep, including about 540 000 breeding animals (65 percent). Effective breed improvement and selection requires that about 10 percent of the sheep used for breeding have the desired characteristics, so about 54 000 heads would be needed in the Republic of Moldova. At present, the number of sheep on certified breeding farms accounts for only about 1 percent of the total herd, and the situation is even more dramatic in the goat sector.

FIGURE 1: AGRICULTURAL PRODUCTION PATTERNS IN THE REPUBLIC OF MOLDOVA, 2001–2012



Source: National Statistical Service of the Republic of Moldova.

FIGURE 2: AGRICULTURAL PRODUCTION IN THE REPUBLIC OF MOLDOVA BY PRODUCT, 2005–2011 (VALUES IN MILLION LEI AND AS PERCENTAGES OF TOTAL PRODUCTION)



Source: National Statistical Service of the Republic of Moldova.

Conclusions

Until the 1990s, the raising of goats was not an attractive activity in the livestock sector, which was dominated by a fairly large cattle and sheep industry. Since 1994/1995, the goat population has increased significantly from about 60 000 to more than 120 000 heads. Goats are included in the same sector as sheep, and milk production from goats has increased the country's overall milk production. In recent years, some breeders have started to specialize in goat production. In the Republic of Moldova, milk production from local goats averages about 300 litres per 210–230 days of lactation. The growing interest of breeders in goat raising has encouraged specialists to import Saanen and French-Alpine goats.

GOAT BREEDING IN MONTENEGRO – CURRENT STATUS AND PROSPECTS

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Abstract

Goat breeding is an important sector of livestock production in the karst area of Montenegro (along the southwestern coast) where natural conditions are significantly less favourable for breeding other ruminant species (cattle and sheep).

The total number of goats in Montenegro is currently about 35 000 animals. In 2012, there were 402 herds raising more than ten animals each and eligible for subsidies on a total of 18 538 animals. Goat numbers have been stable over recent years. Extensive or semi-extensive farming systems prevail – mainly for milk production, while meat is of less importance.

The goat population of Montenegro can be roughly divided into three groups of breeds: i) exotic breeds (mostly Alpine with some Saanen); ii) a few varieties of the indigenous domestic Balkan goat breed, of which the red-coloured variety is the most typical; and iii) cross-breeds of domestic Balkan goats with exotic breeds. The indigenous domestic Balkan breed dominates, with a share of about 50 percent of the total population; crosses account for 35 percent, the Alpine breed for about 10–12 percent, and the Saanen breed for less than 3 percent.

Average milk production is 140 kg/doe, with 3.4 percent fat and 3.3 percent protein content; average meat production is about 15 kg/animal. Total annual production of goat meat (kid meat and the meat of adult and culled animals) is estimated at about 460 tonnes, and annual milk production, at about 5 000 tonnes.

Positive trends in goat production include increases in the number of farmers raising larger herds and in herd size. Consumption in the tourism sector and the generally good reputation of goat products are the main driving forces for these developments.

Key words: goat breeds, extensive goat farming, milk and meat production.

Introduction

Agriculture has many important roles in the Montenegrin economy. Its share in gross domestic product (GDP) is very high, with primary production alone contributing 8 percent of GDP, and agriculture accounts for about 25 percent of total employment. Agriculture is labour-intensive and serves as a social buffer, providing the main or a partial source of income for nearly 50 000 rural households. Its many other important functions include keeping rural areas active, providing products for the processing industry and tourism, and various services.

Traditionally, livestock plays a major role in Montenegrin agriculture, accounting for more than 50 percent of total output. In the past, livestock raising was the main – or even the only – activity in rural areas.

The rearing of ruminants (cattle, sheep and goats) prevails because of the availability of land resources, with pasture accounting for 62 percent and meadows for 25 percent of total agricultural land. Pig and poultry production are less developed, primarily because of the lack of cereal production. Domestic production of meat and milk is far below consumption (including for tourism): self-sufficiency in meat is about 36 percent, and in milk about 80 percent.

The importance of the goat sector is increasing, especially in countries with good conditions for tourism, such as Montenegro. Goat breeding plays an important role in the country's livestock sector, particularly in the southern karst area, where natural conditions are better for rearing goats than other ruminants. The presence of tourist centres also increases the importance of goat breeding by facilitating the placement of goat produce – cheese and kid meat – as unique and high-value products.

This paper discusses the importance of goat breeding within Montenegro's agriculture sector and describes relevant aspects of goat production.

Materials and methods

To prepare this review, desk research was carried out to analyse all relevant data and findings from Montenegro. The main sources of information were scientific papers, a Master's and a Ph.D. thesis, various studies, strategy documents, and data from the official Statistics Office of Montenegro (MONSTAT). The main problem encountered was a lack of official data as MONSTAT did not collect information on the goat population until 2011, when the first results of the Agricultural Census were published (MONSTAT, 2011). It has, therefore, not been possible to present time series and trends in the goat sector.

This paper covers the wider framework for goat breeding, rearing systems, population size and distribution, main breeds, milk and meat production, major challenges and prospects for further development. The indigenous domestic Balkan goat is the dominant breed and is presented in detail, while the lack of data on other breeds means that only general characteristics are described.

Results and discussion

The goat sector

Goat breeding is a very important sector in Montenegrin agriculture. It was even more important in the past; for example, in 1939, the goat breeding population was 180 000 heads (Adžić et al., 1997b), but after the Second World War a law prohibiting goat rearing caused an immediate dramatic reduction in this population, which practically halved to 90 000 heads by 1949. Since then, MONSTAT did not count goat numbers until 2010, when the Agricultural Census found a total population of about 35 000 animals.

Nowadays there are no formal barriers to goat rearing, and goat breeding is becoming a sector of interest for many new farmers and entrepreneurs. New farms have been formed not only in the traditional goat breeding area of the southwestern karstic region, but also in the regions where previously it had been much less important than cattle and sheep breeding.

Rearing systems

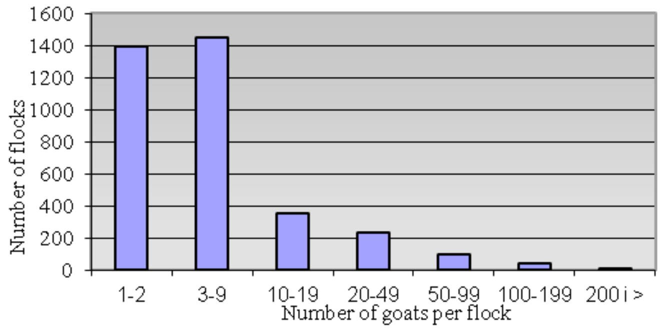
There are two major production systems for goats: relatively intensive production in small herds with highly productive breeds such as Alpine, or sometimes Saanen; and lower-intensity production using the domestic Balkan goat breed. The latter is an extensive or semi-extensive farming system and is practised by the vast majority of goat farmers in Montenegro (Marković, 1997).

The main product is milk, while meat is less important. Milk is processed into various types of cheese. Kids are typically sold in two categories: young kids with live weights of about 15–20 kg; and older kids weighing about 20–30 kg. Input supply and services for goat farms are similar to those in the sheep sector. Major inputs for goat production at the farm level are farmers' own or common pasture and meadowland, and hay for a short period in winter; a few farmers use concentrated feed. Veterinary services are provided by private veterinarians, and other services, by extensionists.

Population size and structure

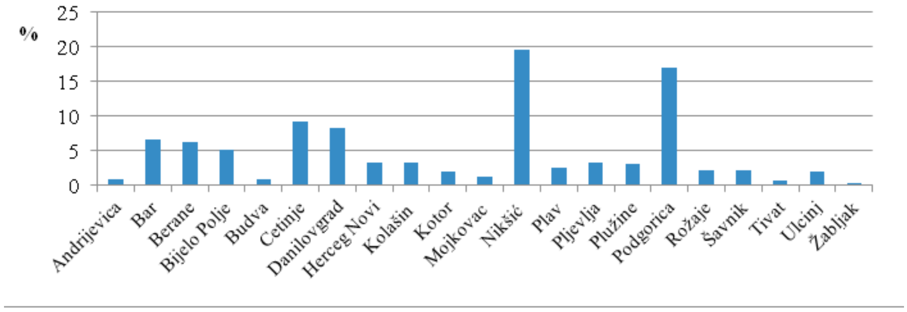
According to the 2010 Agricultural Census, 3 580 agricultural holdings were rearing a total goat population of 35 140 heads. Herds with up to ten heads accounted for about 80 percent of the total number of herds and approximately 30 percent of the total goat population; herds of 10–50 heads accounted for 16 percent of total herds and 40 percent of the population; and larger herds with more than 50 heads for only 4 percent of total herds, but 30 percent of the total population (Marković at al. 2011).

FIGURE 1. STRUCTURE OF THE MONTENEGRIN GOAT BREEDING SECTOR



According to a government report on subsidies, in 2012, there were 402 herds with more than ten goats each, rearing a total of 18 538 breeding animals, with an average of 46 heads per farm. The goat population is unevenly distributed throughout the country. Goats are very important in the southern karstic municipalities of Niksic (accounting for 19 percent of the total population), Cetinje (9 percent), Danilovgrad (7 percent) and Podgorica (17 percent), and along the coast, where natural conditions are less favourable for rearing other ruminants. In northern regions (Andrijevica, Plav, Pljevlja, Zabljak and Savnik), where pasture and meadows dominate total agricultural land, the goat population is very small, and sheep and cattle are the main livestock species.

FIGURE 2. REGIONAL DISTRIBUTION OF THE GOAT POPULATION IN MONTENEGRO



Main breeds

The goat population can be roughly divided into three groups of breeds: i) highly productive breeds, mostly Alpine with some Saanen; ii) a few varieties of the indigenous domestic Balkan goat breed, of which the red-coloured variety is the most typical; and iii) cross-breeds of domestic Balkan goats with exotic breeds. The domestic Balkan breed dominates (Marković et al., 1997; Marković, 2004), with a share of about 50 percent of the total population; crosses account for 35 percent; the Alpine breed for about 10–12 percent; and the Saanen breed for less than 3 percent. The native Balkan breed is generally reared in larger herds; smaller herds are of crosses with Alpine and Saanen breeds.

The domestic Balkan goat originated from Capra prisca (Adametz), which ranged across southeastern Europe; a very similar breed is reared in other Balkan countries. It is a typical primitive breed with very good ability to adapt to scarce nutrition and local rearing conditions and to resist diseases. The main characteristics are a strong constitution and a long, thick, shiny coat. Based on coat colour, there are several varieties of the domestic Balkan breed: red-brown animals are considered to be the typically Montenegrin variety, along with reddish-bay, black, white or spotted goats. Most animals are horned (Adžić and Ljumović, 1981).

The average live weight of breeding animals is about 45 kg, height at withers is 65 cm, and milk yield is 140 kg/lactation/doe, with 3.4 percent butterfat content and a lactation period of 217 days on average. Fertility is 1.2 to 1.3 kids per birth. This breed reacts very quickly to improved conditions, with increasing fertility and milk yield.

Photo 1. Domestic Balkan goat; Photo 2. Alpine goats in Montenegro (source: Bozidarka Markovic, 2014)

The Alpine breed is becoming more popular (accounting for 10 percent of the total population). In the past, the Alpine breed was used only for improving the existing goat population, but over the last ten years, many newly established farms have opted to rear pure-bred Alpine goats. There are no official data or research results on the milk production of the Alpine breed in Montenegro, but personal communications from farmers indicate that each doe produces more than 400 litres of milk in a lactation that lasts for about seven months.

The Saanen breed is reared as individual animals or in very small herds. There are no data or estimates on its performance, but farmers report that milk production can be as high as 4 litres/doe/day, implying a milk yield of 500 kg/lactation.

Crosses of the domestic Balkan goat with other breeds account for a high share of the population (about 35 percent). Again, there are no official data or results on these animals. According to information from the field, crosses are usually raised in the same herds as domestic Balkan goats but produce more milk. The growing popularity of the Alpine breed and its crosses with domestic Balkan goats means that these animals will play a more significant role in the near future.

Performance of the domestic Balkan goat breed

Generally, there is little research on goat breeding in Montenegro. Research on the Balkan breed of goats in Montenegro carried out in the past referred mainly to morphological and milk production traits; meat production traits have been investigated only recently by Markovic at al. (2011).

Body frame development: The findings of Marković (1997) presented in Table 1 show that the body frame of the indigenous domestic Balkan goat is quite small.

TABLE 1. BODY MEASUREMENTS AND WEIGHT OF DOMESTIC BALKAN GOATS IN MONTENEGRO

Lactation	Body measurements (cm)			Body weight (kg)
	Withers height	Body length	Chest circumference	
First	63.10	65.12	75.22	33.95
Second	65.41	67.38	78.26	38.60
Third	66.65	68.74	79.93	41.56
Fourth onwards	67.70	70.01	82.31	44.66
Average	65.71	67.81	78.93	39.69

Source: Marković, 1997.

Milk production: Total annual milk production is estimated at about 5 000 tonnes. Milk is usually processed into various types of cheese. According to findings of the University of Montenegro's Biotechnical Faculty collected in the 1980s and 1990s, average milk production per animal is about 140 kg.

The findings of Marković (2004) and Marković and Marković (2013) show very wide variation in milk traits – lactation duration, milk yield, daily milk yield and fat and protein contents – resulting primarily from differences in rearing conditions and the variety of domestic Balkan goat. The research found that milk yields varied from 136 to 153 kg/lactation (Table 2).

TABLE 2. MILK TRAITS OF DOMESTIC BALKAN GOATS IN MONTENEGRO

Lactation	Lactation duration (days)	Milk yield (kg)	Daily yield (kg)	Fat content (%)	Protein content (%)
First	186.53^{a}	98.97^{a}	0.552^{a}	3.39	3.27
Second	202.03^{b}	135.02b	0.662^{b}	3.43	3.31
Third	207.42^{b,c}	149.21^{c}	0.719^{c}	3.38	3.31
Fourth onwards	210.19^{c}	153.09^{c}	0.727^{c}	3.34	3.29
Average	201.54	140.54	0.665	3.38	3.30

a,b,c = there is a statistical difference between mean values.

Based on the results of previous research in Montenegro, Adžić et al. (1997a) concluded that the genetic potential of the domestic Balkan goat is higher than the results achieved so far. Marković et al., (1999) found that domestic Balkan goats produced an average of 129 litres of milk per lactation of 217.6 days, with significant variation among lactations.

Meat production: According to the findings of many researchers, the production of goat meat, especially kid meat, could be very profitable as there is a good market in most European countries, with high demand and buyers willing to pay high prices (Memiši and Bauman, 2009; Trskot and Pavičić, 2007).

The annual production of goat meat (from young goats and mature and culled animals) in Montenegro is estimated at about 450 tonnes (Table 3), with kid meat being the most important.

TABLE 3. PRODUCTION OF GOAT MEAT IN MONTENEGRO

Category of animal	Heads slaughtered	Average live weight (kg)	Average carcass weight (kg)	Meat production (tonnes)
Culled	6 000	45	19	114
Young kids (suckling kids)	17 000	18	9	153
Older kids (fattened kids)	8 000	25	12.5	100
Fattened bucks	4 000	45	22.5	90
Total	33 000	27.3	13.2	457

Source: ADT Projekt, 2010.

The growth performance of kids during the suckling period is presented in Table 4. The difference in average birth weights between male and female kids was not significant ($P > 0.5$), while at the age of 90 days, male kids had significantly better growth parameters ($P < 0.05$) than female ones.

TABLE 4. GROWTH TRAITS OF KIDS DURING THE SUCKLING PERIOD, AND YIELD AND DRESSING PERCENTAGES OF KID CARCASSES IN MONTENEGRO

Trait	Male (n = 31)			Female (n = 25)		
	Mean	SD	CV (%)	Mean	SD	CV (%)
Birth weight (kg)	3 25	0 39	11 96	3 19	0 46	13 45
Body weight at 90 days (kg)	17 63^{a}	2 12	12 02	16 25b	1 34	8 25
Average daily gain (0–90 days) (kg)	164 3^{a}	0 023	13 75	146 9b	0 012	8 69
Live weight before slaughter (kg)	18.60^{a}	0.89	4.92	16.70b	0.78	4.69
Weight of warm carcass (kg)	10.74^{a}	0.45	4.26	9.87a	0.52	5.17
Dressing percentage of warm carcass	57.76^{a}	1.12	1.98	59.12b	0.93	1.56
Weight of chilled carcass with offal (kg)	10.49^{a}	0.48	4.42	9.60b	0.52	5.26
Dressing percentage of chilled carcass with offal	56.39^{a}	0.91	1.64	57.47b	0.95	1.67
Weight of chilled carcass without offal (kg)	8.33^{a}	0.41	4.65	7.57b	0.41	5.21
Dressing percentage of chilled carcass without offal	44.82^{a}	0.99	2.21	45.31a	0.71	1.56

a,b = there is a statistical difference between mean values.
SD = standard deviation.
CV = coefficient of variation.
Source: Marković et al., 2011.

The differences in live weights before slaughter and weights of warm carcasses between male and female kids were significant ($P < 0.01$) in favour of male kids, while dressing percentages (warm and chilled) were higher in female kids.

Prospects for goat breeding

There is still much unused land available for the rearing of ruminants. Grasslands (meadows) account for 25 percent (127 000 ha) and pastures for 62 percent (323 953 ha) of the total agricultural land (515 740 ha). With a total cattle population of less than 90 000 heads, and a sheep population of about 200 000, it can be concluded that stock density in Montenegro is very low, at less than 0.5 livestock units per hectare.

Regarding market opportunities for goat milk and meat (especially kid meat), as a tourist destination, Montenegro has comparative advantages and good natural conditions. The market demand for goat products, which can be considered as local specialities, has been increasing; consumption by the tourist industry and the generally good reputation of goat products are the main driving forces of this development. The resulting positive trends in goat production include increases in the number of farmers raising larger herds and in the herd size.

However, goat farms still face constraints to becoming more competitive. These constraints are similar to those affecting sheep farming and include low productivity of animals, insufficient levels of technology, structural problems, lack of supplementary feeding with concentrates, and poorly developed village and market infrastructure.

The main advantages and disadvantages can be summarized through an analysis of the strengths, weaknesses, opportunities and threats (SWOT).

The main strengths are that goat farming is a family business with a long tradition; many pastures and meadows are available for fodder production; the goat population is healthy; agroclimatic conditions are favourable for ruminants; positive structural changes include increasing farm sizes; consumers prefer local products (cheese and kid meat); and a legal and strategic framework for goat farming is in place.

Weaknesses include the small scale of production under subsistence farming; low performance in milk and meat production; inadequate buildings, mechanization and equipment; weak collaboration among farmers (horizontal integration) and poor linkages between farmers and markets; underdeveloped rural infrastructure, with particularly difficult access in mountain areas; the ageing of the farming population; a lack of knowledge of modern farm management and European Union (EU) standards; and weak extension and veterinary services.

There are many opportunities: improvements in technology through investments in barns, machinery and equipment; support from national sources (the Ministry of Agriculture and Rural Development) and EU grants (preaccession support to rural development); tourism as a driving force for sales of local products; the development of specialized market segments (niches) for high-value products such as organic goat cheese and kid meat; and increased cooperation with the meat processing sector to improve the market orientation of domestic production.

However, the following threats should not be ignored: the opening of markets can challenge domestic sectors; farmers face problems in obtaining access to bank loans; rural areas are being depopulated; implementation of agricultural policy aligned with the EU may fail; EU requirements may not be met; and implementation of the policy and legal framework needs to be improved.

The main challenges

There are challenges facing Montenegro's goat sector at three levels: at the farm level, in the processing industry, and along distribution channels and on the consumer side.

At the farm level, the main challenges are: i) improving barns, fodder production and goat genetics; ii) strengthening horizontal (producer groups and organizations) and vertical integration; and iii) improving farmers' skills in management, hygienic standards, etc.

At the processing industry level, the main challenges are: i) implementing international standards; and ii) developing better links with farmers.

The main challenges facing distribution channels and the consumer side are: i) promoting and marketing local products to the tourism sector; and ii) increasing public awareness of the importance of local products for the overall economy.

Conclusions

Given the land resources available, the very low livestock density (with fewer than 0.5 livestock units per hectare) and the increasing demand for local products, goat rearing is likely to become increasingly important and attractive. The latest trends in tourism will enable better market positioning of traditional local products based on goat milk and meat, which will facilitate further development in this sector.

New market trends will positively influence the goat sector, enabling it to expand commercial farming and strengthen entrepreneurship in the sector. Organic agriculture has real potential for a large part of the Montenegrin goat sector because of its low-input production.

There are also positive trends in traditional products: i) goat cheese is becoming increasingly attractive to consumers and can reach very high prices; ii) kid meat is a delicacy that is easily marketed; and iii) meat from castrated male animals is traditionally very popular in some parts of the country.

Future development of the goat farming sector will also depend on how well farmers are linked and organized. Institutional support is very important, and is provided by the Ministry of Agriculture and Rural Development, the veterinary service and the University of Montenegro's Biotechnical Faculty, whose Department for Livestock Science provides higher education and research, a livestock selection service and the dairy laboratory.

Last, but not least, harmonization of the country's agricultural policy with the EU's Common Agricultural Policy, and implementation of the new rural development policy in harmony with the EU model of support, will force the government to continue to increase its support to the sector through direct payments and rural development programmes. This will create an even better environment for the development of goat production in Montenegro.

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GOAT BREEDING IN POLAND

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Abstract

The national agricultural census showed that there were 117 268 goats, including 93 490 does, in Poland in 2010. They were maintained on 27 785 farms, which means a significant decrease in the number of herds compared with 2002, while the size of herds increased. However, less than 0.2 percent of this population is included in official milking control. The most numerous breeds are Polish White Improved (about 40 percent of the total population) and Polish Fawn Improved (about 20 percent). There are also pure Saanen goats (about 15 percent), French Alpine goats (3 percent), and some herds of Boer and Anglo-Nubian goats. There is no goat meat market in Poland. Goat milk production was estimated at about 38 000 tonnes, 90 percent of which is processed on-farm for own use or agritourism, or in small, domestic dairies. However, the market for goat milk and its products has increased by 10–15 percent per year. Priorities for action for the development of goat breeding in Poland should include promotion of the use of not only goat milk but also kid meat; awareness raising on the health properties of goat products, both milk and meat; efforts to interest decision-making units (local government) in goat breeding, emphasizing the positive effects of its development; reorganization of breeding; and the creation of a financial support system for goat breeding.

Key words: Poland, goat, breeding, population, market

Introduction

Goat breeding is not a large part of the agricultural economy in Poland, and the goat market is negligible. However, this situation has been changing over the last three decades. The demand for goat products continues to grow, and they are seen as functional foods consumed by children and elderly people, convalescents, patients with malnutrition problems, connoisseurs and people who pay attention to a healthy lifestyle. The dairy goat population has remained stable for several years. Although goat owners do not participate in official milking control, they are very interested in improving their animals genetically, developing their herds, and increasing their production and income. The main requirement for development of the goat sector is increasing the demand for goat products on the domestic market and for export. However, development of the sector needs the support of a system. The aim of this review was to examine the goat-breeding situation in Poland and ways in which decision-making units could support the goat sector.

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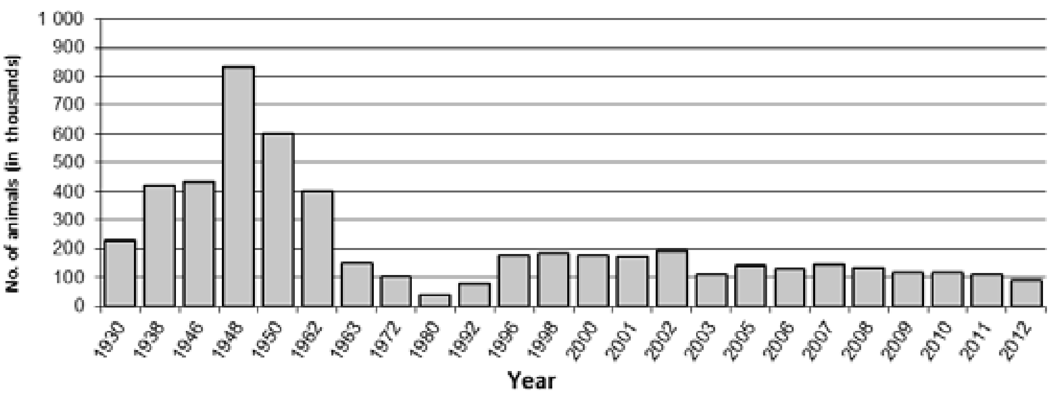
Materials and method

This report is based on work carried out during development of the National Strategy for Sustainable Utility and Conservation of Genetic Resources of Farm Animals, which was prepared as part of the Global Plan of Action for Animal Genetic Resources for Food and Agriculture.

History of goat keeping in Poland

There is not a great tradition for goat breeding in Poland. In the Middle Ages, when the countries of Western Europe had large populations of dairy goats, goat rearing was poorly distributed in Poland. Historians claim that the development of goat breeding was inhibited by a deeply rooted cultural superstition that the devil often takes the form of a goat buck (Mączak et al., 1981). Moreover, goat milk was considered inferior to cow milk. By the nineteenth century, Poles still had negative attitudes towards goats and their products, which were associated with poverty. It was only at the end of the nineteenth century that Polish breeders tried to change these attitudes. In the period between the two World Wars, the goat population remained small, but a steady increase was observed, from 227 000 heads in 1930 to 420 000 in 1938 (Figure 1). However, compared with the populations of dairy cows and sheep (more than 7 million and 3 million, respectively in 1938), this was not much. The human population was almost 35 million in that year. Goats were maintained mostly on small farm or residual plots in industrialized areas. Only 2 000 goats were bred on large farms of more than 50 ha, mostly in Poznan province (today's Wielkopolska province) (GUSRP, 1939). After the Second World War, the goat population consisted of 432 500 animals; there was then a rapid increase to 832 000 goats by 1948. This population growth resulted from the high demand for animal protein; with their low nutrient requirements and high fertility, local breeds of goats could quickly make up for the devastation of populations of other farm animals that resulted from war. Along with the reconstruction of the country, development of traditional farming industries (cows, pigs, sheep) and increases in people's standard of living in 1948–1972, there was a decrease in the goat population to 104 000 animals. The agricultural policy of the 1970s led to the abandonment of goat breeding. The mating points with licensed bucks were closed and herds in research institutions were liquidated. There were probably only 40 000 goats in Poland in 1980, and they were not included in official statistics (Kowalski and Pyś, 1982). The redevelopment of dairy goat breeding started in the 1980s. Since 2003, the goat population has remained stable.

FIGURE 1. GOAT POPULATION OF POLAND, 1930–2012



The cradle of this new goat breeding is Lower Silesia (Opole province) and to a lesser extent Upper Silesia (Katowice region), where goat breeding survived despite the unfavourable agricultural policy. At the same time, the popularity of "ecological" or "healthy" products and the interest in functional foods was growing worldwide, and the improvement in living standards created a demand for more sophisticated tastes. Thus, goat products became very fashionable, resulting in increased demand. The first Goat Breeding Association was established in 1982, and the control of milk and reproduction traits started in Opole region in 1983. At the end of the 1980s, both does and bucks were imported from the former Czechoslovakia (White Shorthaired goats) and the former German Democratic Republic (German White Improved and German Fawn Improved). The mothers and grandmothers of these goats were characterized by very high milk yields of more than 1 000 kg per lactation. The animals reared in Lower Silesia played a major role in the recovery of goat farming in Poland. A large part of the breeding material distributed throughout the country during this period came from this region. In the early 1990s, there were relatively large imports of goats from Belgium, France and the Netherlands. The Saanen and Alpine breeds were most popular among Polish farmers. It was probably also in this period that the caprine arthritis encephalitis virus was imported, which spread very quickly throughout the Polish goat population (Kaba and Bagnicka, 2009).

The current role of goats

According to the national agricultural census of 2002, there were more than 193 000 goats in Poland, including 111 000 does (GUS, 2003); the agricultural census of June 2010 showed that there were 117 268 goats, including 93 490 does of at least one year of age (GUS, 2011). These animals were maintained on 27 785 farms, which means that there had been a significant decrease in the number of herds compared with 2002 (68 000), while the size of herds increased (from 2.8 animals, including 1.6 does, in 2002, to 4.2 animals, including 3.4 does, in 2010). For comparison, in 2010, there were 1 060 700 farms (46.6 percent of all farms maintaining livestock) keeping cattle, with a total population of 5 760 585, including 2 516 725 dairy cows.

In both 2002 and 2010, most farms maintained only a single goat. Large herds counting 20 or more goats accounted for 1.6 percent in 2010 (0.6 percent in 2002). Between 2002 and 2010, there were increases in the proportions of herds maintaining 5–9 goats (from 10.3 to 13.3 percent) and 10–19 goats (from 1.8 to 3.5 percent). Low average herd size is usually characteristic of the extensive system of animal husbandry, which prevails in Poland.

Active population size and breed structure

Although the entire population of dairy goats in Poland counted almost 100 000 does in 2010, less than 0.2 percent of this total was in the active population included in official milking control. By 2007, the number of goats had increased steadily and more than 5 percent of the population was included in milking control (Figures 2 and 3). It became possible to use modern methods to estimate breeding values. Until 2006, the costs of milking control were lower than the support provided by the Fund for Biological Progress. However, when goat farming subsidies ceased, many farmers stopped participating in the milking recording programme and the active population of goats fell drastically after 2007 (from 105 herds in 2006 to 36 in 2007). There were only 19 herds with 192 does under official milking control in 2013 (PZOw, 2014).

The most numerous breeds in the active population before 2007 were Polish White Improved (40 percent of the active population) and Polish Fawn/Coloured Improved (21 percent). There were also pure Saanen (16 percent) and French Alpine goats (3 percent) (PZO, 2008). This breed structure more or less reflects the structure of the whole goat population. Recently, there have also been herds of Boer and Anglo-Nubian goats.

FIGURES 2. NUMBERS OF HERDS IN THE ACTIVE POPULATION INCLUDED IN OFFICIAL MILKING CONTROL IN POLAND

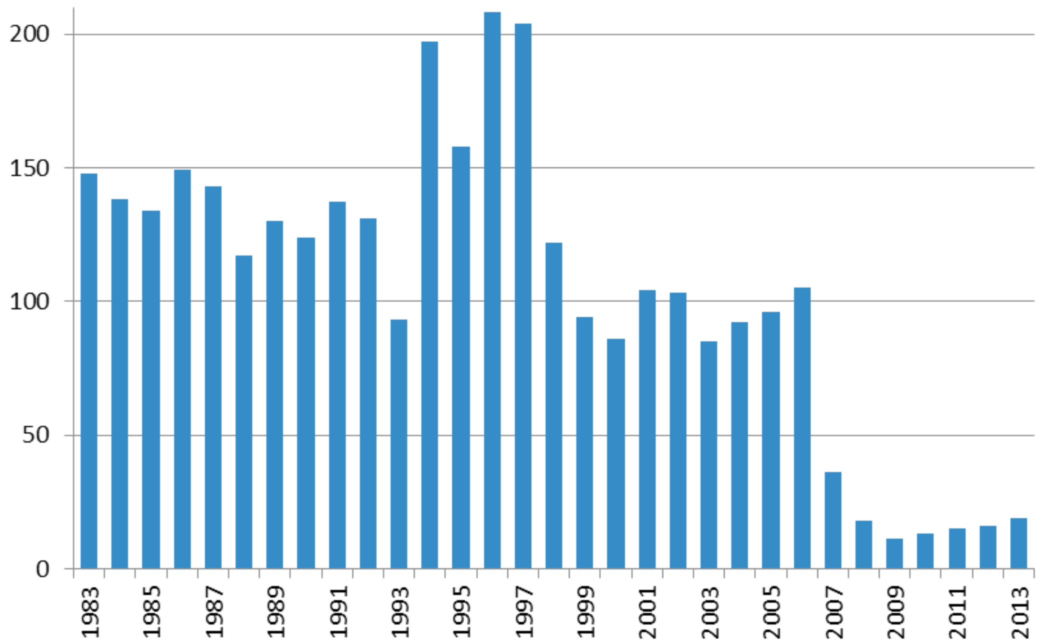
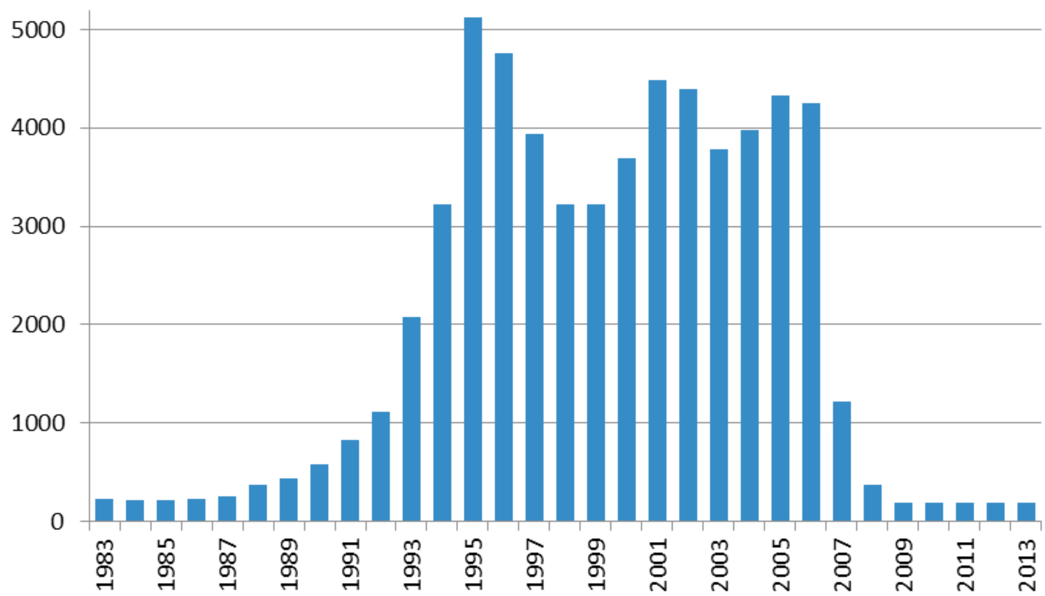


FIGURE 3. NUMBERS OF GOATS IN THE ACTIVE POPULATION INCLUDED IN OFFICIAL MILKING CONTROL IN POLAND



Polish White Improved goats are descendants of local breeds with white coats. The most numerous population of this type of goat survived in Opole region. These goats were mated with Czech White Shorthaired bucks imported from the former Czechoslovakia, and German White Improved bucks from the former German Democratic Republic. In the 1980s, male breeding material from Opole region was sold to other regions of Poland for mating with local white goats. After the political restructuring of Poland, in 1990 imports from Belgium, France and the Netherlands started, and Saanen bucks were used to improve Polish White Improved goats. The goats of this Polish breed are large. Females measure about 70 cm at the withers and weigh 45–65 kg, while males measure 80 cm and weigh 60–100 kg. Animals should have a white coat, and grey spots on the udder are allowed only in older goats. Hair is short, and ears are erect and face forwards. Animals with vestigial ears are eliminated from breeding. Animals of both genders are bearded and can be horned. However, the offspring of two hornless parents can be hermaphrodite. The milk yield can reach 1 400–1 500 kg in 260–280 days of lactation, but the average is about 600–700 kg. Fertility is 92–97 percent, and prolificacy 160–185 percent.

Polish Fawn Improved goats were derived from local goats maintained in Upper Silesia and Opole province. These animals were improved by mating with German Fawn Improved and French Alpine bucks. Currently, they are kept throughout Poland. They are similar in size to the Polish White Improved breed. Females measure about 65 cm at the withers and weigh 45–60 kg, while males measure 80 cm and weigh 60–100 kg. Animals should have a red-brown coat, with a dark stripe along the back and darker legs. Hair is short, and only the hair along the back can be longer. As in Polish White Improved goats, animals of the Polish Fawn Improved breed have erect and forward-facing ears, while vestigial ears are not allowed. Animals of both genders are bearded and can be horned; the offspring of two hornless parents can be hermaphrodite. The average milk yield is about 600–700 kg, but can reach 1 400 kg. Fertility is 87–97 percent, and prolificacy 160–175 percent.

Three local breeds were recognized in Poland: sandomierska in Sandomierz region; kazimierzowska, in the region around the town of Kazimierz Dolny; and Carpathian, which were maintained in the Carpathian Mountains. Sandomierz and Kazimierz Dolny are situated to the central-southeast of the country. The mountains lie on the southern border. The sandomierska breed was characterized by long hair and were white pinto goats (grey, black or yellowish-brown). Kazimierzowska goats were black with long thick hair. A characteristic feature of this breed was the golden-yellow colour of the iris. The milk yield of both breeds was about 300–400 kg per lactation. Local breeds are characterized by excellent adaptation to local environmental conditions, but they usually have low yields and so they almost disappeared. Carpathian goats are not only a Polish breed, but were bred in the whole territory of the Carpathian Mountains. The largest population is in Romania, but these differ from those in Poland, which are white with long hair, while the coats of Romanian goats are of different colours. Polish Carpathian goats are small: does measure 45–55 cm at the withers and weigh 30 kg, and bucks measure 55–60 cm and weigh 55 kg. These goats have long hair and erect, forward-facing ears. They are bearded and all animals are horned. Most animals have a characteristic fringe. The milk yield is about 450 kg per lactation, fertility is 100 percent, and prolificacy 150–160 percent (Kaba and Bagnicka, 2009).

The role of goats in food production

At present there is no goat meat market in Poland and goat meat production is of very little importance. Polish eating habits result in negligible demand, which is limited to the largest cities and associated with a small group of restaurants serving gourmet food and, particularly, the cuisine of Arab countries. In the 1990s, a small number of live kids were exported to Italy before Easter. The prices of slaughter kids did not differ from those of lambs. Kids were sold when they weighed more than 9 kg (2 000–4 000 kids a year). However, exports have been negligible for a long time. Currently, only six herds are under official control, with 98 does and 9 bucks of the Boer breed. Boer bucks are also used for breeding goats of dairy breeds to obtain progeny with improved traits for meat production. However, there is no economic rationale for rapid development of goat meat production.

The average milk yield of goats under official control ranges from 500 to 700 kg per lactation, and the average productivity of goats in the uncontrolled population is probably lower. Goat milk production was estimated at about 38 000 tonnes in 2002 (Niżnikowski, Strzelec and Popielarczyk, 2003) and has most likely remained at a similar level. More than 90 percent of milk is processed on-farm for own use or in agritourism, or in small, domestic dairies for direct sales at fairgrounds and festivals, or through delivery to small health/organic food shops. For comparison, the production of cow milk is about 12 million tonnes.

The market for goat milk and its products has increased by 10–15 percent per year, even though the lack of funds for promotion and awareness raising restricts its development. Exports have also been developing recently, mainly to the Czech Republic, Estonia, Lithuania and Ukraine. Goat products imported into Poland come mainly from France and Greece.

As already mentioned, many of the farms keeping dairy goats in herds of various sizes (from a few to hundreds) process the milk in their own factories. These small factories produce a variety of products: cottage cheese, rennet, salted, matured and whey cheeses, yoghurt, butter, ice cream, pastries and confectionery supplies. Large commercial farms do not usually process their own milk, and, instead, sell it to one of several dairies that buy goat milk. Currently, these dairies buy more than 6 percent of the total production of goat milk. The price of milk depends on the conditions of its delivery. Dairies that collect milk directly from farms two or three times a week offer prices that are 15–30 percent lower than those offered when the farmers deliver the milk themselves.

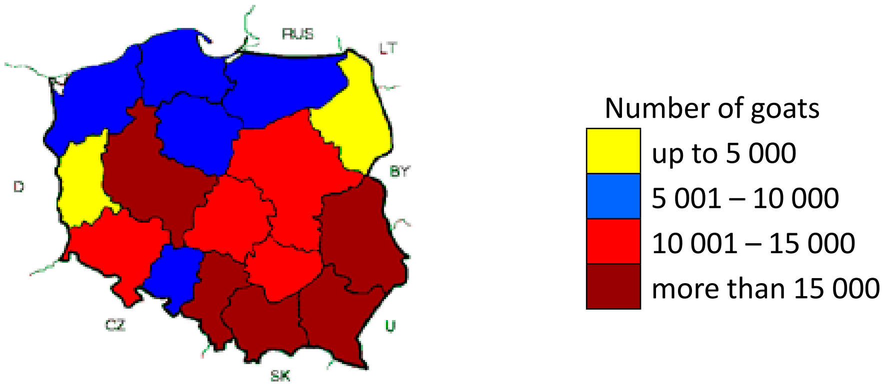
Since 2000, the price of milk has increased by about 30 percent. Goat milk is twice as expensive as cow milk. Recently, dairies have introduced a payment system for milk that takes into account the protein and fat content and the number of microorganisms, and uses a system of subsidies for the quantity of milk supplied in a given month.

Small ruminants can also be used for the active conservation of nature. The grazing of animals of native breeds on semi-natural pastures can be a source of additional revenue as part of an agro-environmental programme. Traditional grazing systems are now the basis for developing agri- and ecotourism, which – when native breeds are used – also contribute to revitalizing these breeds. In the social dimension, it is important that farmers are viewed increasingly as not only producers of food but also guardians of the environment and natural landscape. For the environment, animal husbandry based on grassland contributes to the conservation of biological diversity of semi-natural habitats. This use of small ruminants is especially important because 20 percent of Poland's territory is covered by the Natura 2000 network. At the same time, goats and other small ruminants also have a cultural function as providers of traditional foods, which are currently fashionable. This function contributes significantly to the development of local tourism and crafts, making goats an important factor in stimulating regional economies. For example, goats are an increasingly popular feature of agritourism, which is based on accommodation and activities related to farms and their surroundings. With their relatively small body size and calm nature, goats do not raise anxiety in humans. Communing with small ruminants can inspire people to learn about the animals' biology and behaviour, stimulates a sense of responsibility and care, and encourages a wider interest in the animal world. Contact with animals for recreational purposes has a positive effect on the personality, especially among children, who are the most enthusiastic participants in agritourism. The presence of goats in agritourism also provides a source of their products (milk, meat). Food and goods made from the milk, meat and skins of goats can be an additional source of income for farms in a region.

Projects for the development of goat breeding in Poland

Since 2007, the active population of goats in Poland has declined rapidly, but the total goat population has remained at a similar level since the 1990s (Figure 4). It is estimated that the market for goat products will grow slowly but steadily, so the goat population should not decrease, and may even increase. Linked to implementation of the national programme for the conservation of genetic resources of livestock, since 2009 the Carpathian breed has been protected. This breed, which was considered extinct, was reintroduced in 2005 by the National Research Institute of Animal Production in Krakow. In the coming years, the population of Carpathian goats in Poland is expected to reach 500 does.

FIGURE 4. DISTRIBUTION OF GOATS ACROSS PROVINCES IN POLAND, 2010



Source: GUS, 2011.

Despite the small goat population compared with that of dairy cows, goat rearing is an option for Polish farmers seeking to stave off bankruptcy; it may also help them develop their farms. However, it is necessary to support the goat sector, especially by promoting goat milk, meat and their products, primarily as functional foods, to expand demand.

There is also need to promote goat products manufactured in Poland so that they can compete successfully with imported products. For this purpose, recipes for goat products that respond to consumer tastes should be developed. A large barrier to purchasing goat products is their retail prices in shops, which are often unreasonably high because of the mechanisms of the market.

Priority actions for the development of goat breeding in Poland

- Promoting the use of goat meat, as currently goats are used mainly as a source of milk.
- Raising awareness on the health properties of goat products, both milk and meat.
- Intensifying efforts to interest decision-making units (local government) in goat breeding, emphasizing the positive effects of development of this sector.
- Increasing the use of goats in active nature conservation.
- Reorganizing the breeding programme, by returning to the form that existed until 2006 or establishing an open breeding centre.
- Creating a system of financial support for goat breeding in collaboration with decision-making units (Ministry of Agriculture and Rural Development, local offices, etc.).

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CURRENT STATUS OF AND PROSPECTS FOR GOAT FARMING IN THE RUSSIAN FEDERATION

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Abstract

The popularity of commercial goat farming is increasing in the Russian Federation. This article examines the development of goat breeding in the country from 2000 to 2012 and the prospects for the industry. While the number of goats in the world increased significantly during this period (by 32.5 percent), in the Russian Federation it decreased by 4.2 percent, to 2.1 million heads in 2012. However, the number of breeding goats in the country increased more than 2.5-fold during this period. Currently, 10 percent of goats in the Russian Federation are bred in agricultural enterprises, and the other 90 percent are owned by private farms. The goat population comprises seven breeds: four downy, two wool and one dairy. Among the countries of the world, the Russian Federation ranks fifty-ninth for per capita goat milk production and one hundred and twenty-fifth for per capita goat meat production.

There are almost no meat goat breeds in the country. An effective way of developing modern goat breeding in the Russian Federation would be to create hybrids of domestic and wild goats, which would enrich the gene pool of native breeds by introducing valuable genetic traits.

To conserve the genetic resources of Capra spp. a cryobank storing the ejaculated sperm of domestic goat breeds and the epididymal sperm of wild goat species has been established. Using epididymal sperm from the Capra sibirica species, fertile F1 and F2 hybrids of domestic goats have been produced. This confirms the value of intraspecies hybridization as an effective tool for conserving wild Capra sp. and introducing the unique alleles of wild animals into domesticated goat breeds.

Goat farming has always existed in the Russian Federation, but goat products have generally been for personal consumption only. Experts are now predicting rapid development of a goat industry based on government support and investments from private businesses and conforming to global trends.

Key words: goats, meat, milk, genetic resources, cryobank, Capra sibirica

Introduction

Goat breeding is an important global livestock industry. There is noticeable growth in this sector. Thus, the number of goats in the world increased from 751.6 million heads in 2000 to 996.1 million in 2012 – an increase of 32.5 percent. In 2012, goats ranked as the world's sixth most important species for meat production and third for milk production. Increases in meat and milk production amounted to 41.3 percent and 39.2 percent, respectively between 2000 and 2012. Goats are also sources of valuable raw materials for processing industries, with their wool, down and skins.

The natural and social characteristics of the Russian Federation give it great potential for development of this sector of animal breeding. According to data from the Ministry of Agriculture, in several regions with particularly high potential, numbers of sheep and goats are increasing and returning to their levels of 20 to 30 years ago. The country has only one registered dairy goat breed and no registered meat goat breed. Currently, as well as importing pure-bred animals of international breeds, the Russian Federation is also working to establish new breeds of farm animals using the adaptive capacity of wildlife. This is particularly topical for the Russian Federation with its vast territory covering different climate zones at different altitudes. Scientists of the All-Russia Scientific Research Institute for Animal Husbandry (in Dubrovitsy, Moscow region) have established a cryobank of semen from the Altai population of Siberian ibex (Capra sibirica). In 2008, to obtain new breeding types and create a new breed, viable hybrids of Siberian ibex and Saanen goats were obtained at the institute for the first time in the world (Dankvert, Holmanov and Osadchaya, 2011).

Materials and method

The authors of this paper analysed the goat breeding sector of the Russian Federation by using traditional economic and statistical methods to collate and process voluminous statistical data provided by FAO, official statistics from the Ministry of Agriculture, and scientific publications. The parameters considered were the numbers and distribution of goats across the country, and the structure of this livestock population by farm type and breed composition.

The cryobank of epididymal semen from Siberian ibex (C. sibirica) was created to facilitate conservation and sustainable use of the gene pool of wild goats. The testes of animals living in Altai Mountains were obtained post mortem, and the epididymal semen was then isolated and frozen in liquid nitrogen using the institute's own procedure.

To produce F1 hybrids, ten goats of the Saanen breed (C. hircus) were inseminated with the epipidymal semen of C. sibirica, using adapted instruments. F2 hybrids were then produced by inseminating Saanen goats with semen from F1 hybrid males.

Results and discussion

According to official statistics, on 1 January 2014 there were 2.09 million goats in the Russian Federation. The population had decreased by 1.2 percent compared with the previous year, following a gradually declining trend since 1990, when the goat population was 3 million heads. The share of Russian goats in the world goat population has always been small, and decreased from 0.45 percent in 1990 to 0.2 percent in 2012.

There are goats in all regions of the Russian Federation, other than areas with permafrost. The largest share of goats belongs to private farms located in the country's south, in Altai, Bashkortostan, Trans-Baikal Territory and Orenburg region. This distribution corresponds to the traditional way of life of the population in these parts of the country.

In the Russian Federation, selection (breeding) work is not carried out by private households but only by agricultural organizations. However, according to experts, 47 percent of all Russian goat farms rear coarse-haired (meat) goats. The share of dairy goats is 40 percent, while downy and wool goats are reared by 12 percent of goat farms (Novopashina and Sannikov, 2013).

Currently, 10 percent of Russian goats are owned by agricultural enterprises, and the remaining 90 percent by private farms (households) (Figure 1).

The number of goats has fallen since 2000, mainly because of a reduction in the numbers kept by private farms (households). However, over the same period, the number of breeding goats has increased more than 2.5-fold (according to regional pedigree services).

There are 559 breeds of goats in the world (FAO, 2007), of which 15 are present in the Russian Federation. Currently, breeding farms rear seven breeds: four downy, two wool, and one dairy (Table 1, Figure 1).

Downy breeds include Altai Mountain (Gornoaltaiskaya), Dagestan White (Belaya Dagestanskaya), Orenburg (Orenburgskaya) and Don (Pridonskaya) and account for 31.5 percent of the goats of agricultural enterprises. This number increased by 64.3 between 2000 and 2012.

Wool breeds include Soviet wool and Dagestan (Dagestanskaya) and account for 58.5 percent of the goats of agricultural enterprises. The numbers of goats in this group increased by 226.7 percent from 2000 to 2012.

The dairy breed reared by agricultural enterprises is the Saanen (Zaanenskaya) breed, which accounts for 8.5 percent of all goats. Numbers of this breed increased by 156.5 percent from 2005 to 2012.

Analysis by Bagirov et al. (2013) found that goats of the Altai Mountain breed exceeded the breed standards for down (by 77.2 percent for males and 46.0 percent for females) and body weight (by approximately 13 percent) (Grigorian et al., 2012).

FIGURE 1. BREED STRUCTURE OF THE GOAT POPULATION IN THE RUSSIAN FEDERATION

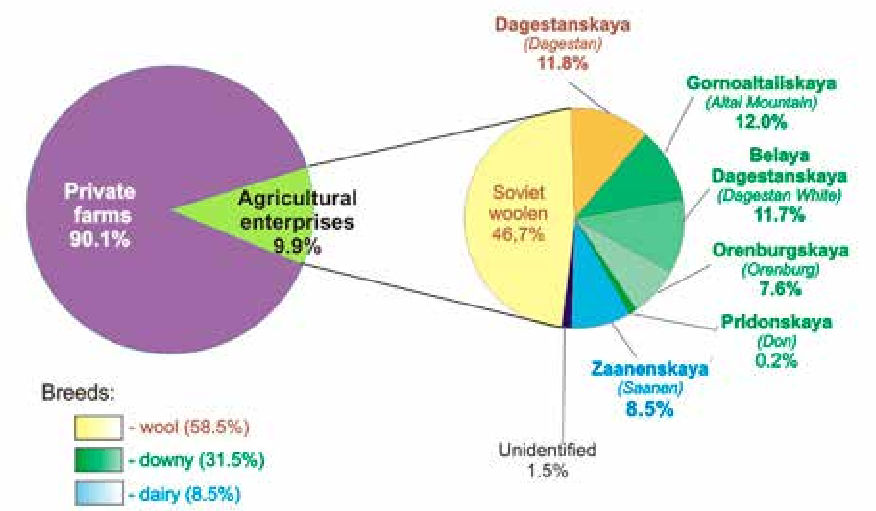

TABLE 1. GOAT NUMBERS IN AGRICULTURAL ENTERPRISES IN THE RUSSIAN FEDERATION, BY BREED (AT END OF YEAR IN THOUSANDS)

Breed	1991	2000	2005	2010	2011	2012	Change 2000–2012 (%)
Wool breeds	151.7	37.5	105.4	101.2	111.5	122.5	+226.7
Soviet wool	141.9	31.7	88.7	81.6	88.1	97.9	+208.8
Dagestan	9.8	5.8	16.7	19.6	23.4	24.6	+324.1
Downy breeds	244.4	40.3	72.1	76.3	64.7	66.2	+64.3
Orenburg	111.7	16.9	22.8	20.5	16.8	15.9	-5.9
Altai Mountain	109.9	15.7	11.3	27.3	24.1	25.2	+60.5
Don	13.0	2.0	1.6	-	0.5	0.5	-75.0
Dagestan White	9.8	5.7	16.6	19.5	23.3	24.6	+331.6
Milk breeds	-	-	1.1	6.9	14.8	17.7	+156.5
Saanen		-	1.1	6.9	14.8	17.7	+156.5
Total	396.1	80.6	178.6	175.4	191.0	206.4	+156.1
Unidentified	-	2.8	8.7	8.8	8.5	3.2	+14.3

In contrast, Orenburg goats did not attain breed standards for live weight. Animals of the Soviet wool breed exceeded the standard for live weight in males (by 8.6 percent) and attained it in females. Wool shearing was 5.1 percent below the standard for males and 27.9 percent for females. Saanen goats exceeded the breed standards for live weight by 15.0 percent in males and 20.0 percent in females, and exceeded the breed standard for milk yield by 11.9 percent.

The dairy goat breeding industry

There is currently a gradual increase in demand for goat milk worldwide. Between 2000 and 2012, global goat milk production increased by 39.2 percent with annual increases ranging from 151 000 to 730 000 tonnes. Although the production of goat milk in the Russian Federation decreased by 21.6 percent over the same period, there is a move to develop goat milk production. The importation of goats from Australia, Switzerland and the United States of America in the 1990s drove a revival of old breeding farms and the creation of new farms and enterprises. Using the breeding farms in Stavropol as a model, breeding farms were established in the Penza, Kursk, Belgorod and Moscow regions, the Republics of Kabardino-Balkaria, North Ossetia, Chuvashia, Tatarstan and Bashkiria and other parts of the Russian Federation. Some farms are both breeding and industrial farms using intensive technology.

Currently there are only about a dozen large goat-breeding farms in the Russian Federation, but the recent trend in creating goat farms is likely to increase this number. Non-breeding goat farms are also being developed, including industrial farms with intensive housing, which may become breeding farms in the future.

Development of a modern dairy goat breed is not possible without importing animals from other countries: 330 goats were imported into the Russian Federation in 2010 and 313 in 2011. All the goats imported in 2010 were pure-bred Saanen goats for breeding. The goats imported in 2011 were of the Saanen and Girgentana breeds; Nubian goats are also imported in small quantities.

Meat goat breeding industry

From 2000 to 2012, the number of meat goats worldwide increased by 37.9 percent while goat meat production increased by 41.3 percent. World meat production in 2012 was 5.3 million tonnes. Again, in the Russian Federation, meat production decreased

– by 14.3 percent – over the same period. In 2012, the country ranked forty-second in the world for goat meat production. While the proportion of meat goats increased worldwide from 1.63 percent in 2000 to 1.75 percent in 2012, in the Russian Federation it decreased from 0.46 to 0.21 percent, demonstrating the critical state of the goat meat industry in the country.

In the Russian Federation, the number of goats reared for meat has remained almost unchanged (at about 1 million heads) for a long time. However, as already mentioned, no meat goat breed is registered and there is no industrial goat meat production. All goat meat production is carried out on private and smallholder farms.

Wool and downy goat breeding industry

The down and wool industries are in crisis because of the price disparities between these products and the resources used for their production, and the inadequacy of government support for this sector. With no State programme financing downy and wool goat breeding, it is impossible to maintain existing, unique downy and wool goat breeds. Processors' interest in supporting domestic wool production is reflected in Federal Government Resolution No. 269 of 3 March 2012, under which the uniforms for federal executive bodies were to be made from domestic worsted materials until 2014.

Results of the cryobank

The mortality of thawed spermatozoa from the cryobank was 55 percent, and acrosome integrity was 69 percent.

Of the ten goats inseminated, eight became pregnant after a single insemination of epididymal semen from C. sibirica. The offspring had good viability and were characterized by increased growing capacity. The average daily weight gain of hybrid animals was 280–320 g comparing with 180–220 g in goats of the Saanen breed.

Measurement of the body conformation traits of adult animals showed that compared with the original domestic animals, hybrids had increases of 24.3 percent in withers height, 22.2 percent in rump width and 16.6 percent in body depth.

The hybrids had no abnormality in development and were fertile. More than 200 F2-hybrids were produced by insemination of Saanen goats with semen from F1-hybrid males. These F2 animals will be used as the basis for creating a new meat goat breed.

Conclusions

Although sheep and goat breeding has declined over the last two decades, these areas of animal husbandry have not lost their economic attractiveness.

As long as the right conditions are established – including the construction of workshops and plants for the processing of sheep and goat products and the development of a favourable procurement policy – it is likely that sheep and goat numbers on small and large farms in the Russian Federation will increase substantially in the near future. Output volumes will therefore also rise.

According to data from the Russian Ministry of Agriculture, sheep and goat numbers were only 18.5 percent of their 1990 levels in Krasnodar, 37 percent in Rostov, about 30 percent in Volgograd, 35 percent in Bashkortostan, 22 percent in Buryatia and 20 percent in Novosibirsk. The unrealized potential of these livestock industries is therefore about 70 percent across the Russian Federation. According to federal indicators of the land market,[30] the economic efficiency of agricultural land use in the Russian Federation is only a fraction of that in European Union countries.

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State support plays an important role in development of the sheep and goat breeding sectors. In 2013, State support was preserved through Federal Government Resolution No. 339-p of 12 March 2013. Subsidies for reimbursing the costs of increasing breeding stock in all branches of the goat and sheep sectors amounted to about €15 million in 2013.

Russian experts believe that goats of the Saanen breed should be used to create medium-sized and large industrial farms because: i) this is the only dairy goat breed included in the State register of breeding activities permitted in the Russian Federation, so its use would facilitate the creation of new breeding farms; and ii) a pedigree stock for breeding Saanen goats has already been created in the country, so use of Saanen breeding material would avoid the need for complex and expensive animal imports from other countries.

Goat and sheep breeding is currently very relevant because it gives private farmers an option for replacing their pig breeding activities following outbreaks of African swine fever. Unused areas of the Russian Federation have considerable potential for expansion of sheep and goat farming.

To conserve the wild goat species and enrich the gene pool of domesticated breeds with valuable genetic traits, F1 and F2 hybrids between domestic (Saanen, C. hircus) goats and wild (C. sibirica) goats were produced. Given the good viability and increased growing capacity of these hybrid forms, they will be used to create a new meat goat breed.

Goat farming has always existed in the Russian Federation, but goat products have generally been for personal consumption only. Experts predict that the industry will develop rapidly with government support and investments from private businesses, in line with global trends.

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GOAT PRODUCTION IN VOJVODINA, SERBIA

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Abstract

In the 1990s, a shortage of goat products on the market led to the development of goat production in Serbia, especially in the Autonomous Province of Vojvodina in the country's north. Farmers imported goats with high genetic potential for milk production, primarily of the Saanen and Alpine breeds. On these farms, goat production is oriented to the market. Of the estimated 225 000 goats in Serbia in 2013, only 1.53 percent– mainly in Vojvodina – were under the selection control programme. These goats were of four breeds (Alpine, Saanen, Serbian White and Balkan), of which the Alpine goat was the most numerous. Average milk yields per lactation were 672.23 kg for Alpine goats and 620.29 kg for Saanen goats. The average numbers of kids per kidding were 1.89 for Alpine goats and 1.78 for Saanen goats.

Key words: Vojvodina, Serbia, goat production

Introduction

In the former Yugoslavia, goat keeping was forbidden under a law that was in effect from the early 1950s to the mid-1980s. However, in Serbia in the 1970s there were small populations of Balkan goats, as the law was not strictly observed. Goat breeding started to develop with imports of Saanen and Alpine goats for crossing with Balkan goats to improve milk production. Over the last ten years, breeders in lowland Serbia (the region of intensive agriculture production) have become interested in intensive goat milk production. They have built modern goat farms and dairies, and imported herds of Alpine and German Fawn goats.

In the 1990s, a shortage of goat products on the market led to the development of goat production in Serbia, especially in the Autonomous Province of Vojvodina in the country's north. Farmers imported goats with high genetic potential for milk production; primarily, Saanen and Alpine breeds (Ćinkulov, 2009). On these farms, goat production is oriented to the market. Goats are kept intensively, in line with the model in European countries with developed goat production. Goat milk processing has also been developed. Although farmers' interest in goat productions is growing, the number of animals under the controlled breeding programme remains very low, because only breeders with valuable dairy goat breeds participate. Of the estimated 225 000 goats in Serbia in 2013, only 1.53 percent were involved in the breeding programme (Figure 1). Most of these goats were in Vojvodina.

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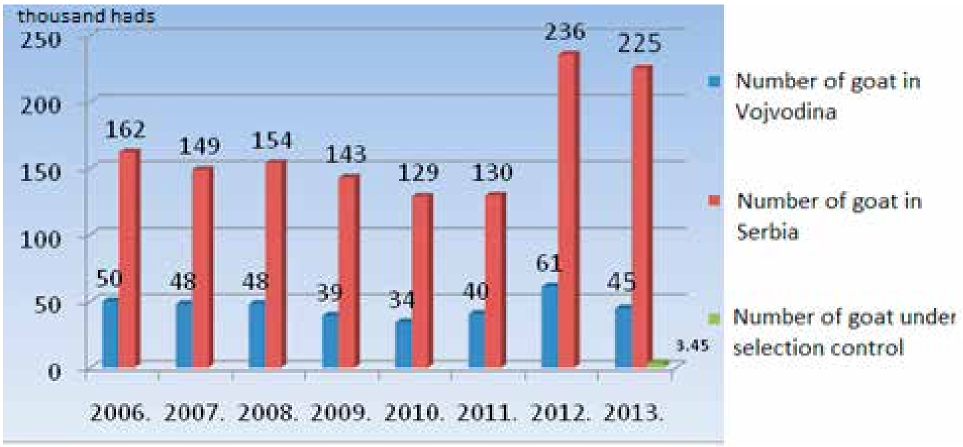
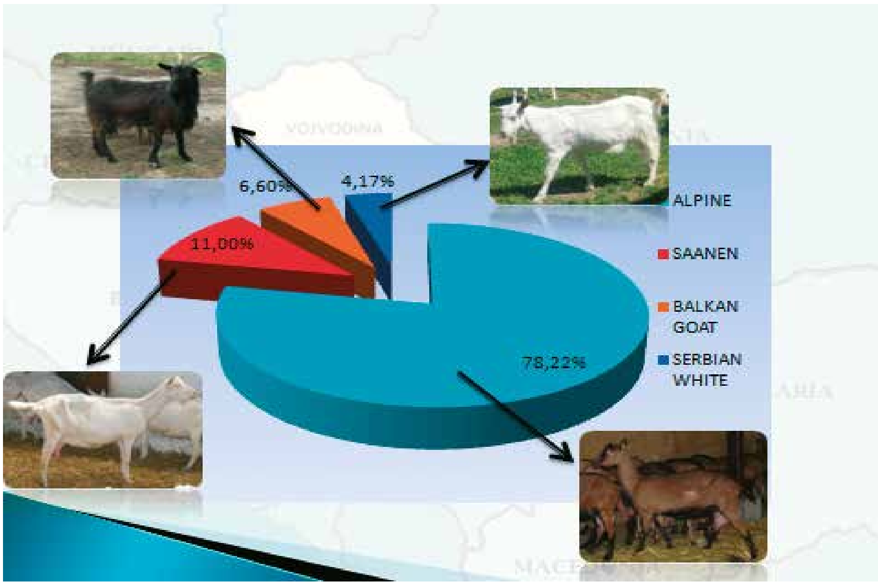
FIGURE 1. TOTAL NUMBER OF GOATS AND NUMBER OF GOATS UNDER SELECTION CONTROL IN SERBIA AND THE AUTONOMOUS PROVINCE OF VOJVODINA



In Serbia, four breeds are under selection control – Alpine, Saanen, Serbian White and Balkan – of which Alpine goats are the most numerous. The average herd size under the breeding programme in 2013 was 92.71 heads, while most breeders had 30–120 heads. In 2012, the average herd size under controlled breeding was 115.68 heads, 23 more than in 2013. The average herd size on commercial farms outside the selection programme, which account for most of the goat population in Serbia, is not known but is assumed to be 10–20 heads. The breed composition of animals in commercial herds is also unknown, but is assumed to consist mainly of cross-breeds of Alpine and Balkan goats. Figure 2 shows the breed composition of goats under the breeding programme.

FIGURE 2. BREED COMPOSITION OF GOATS UNDER THE MAIN BREEDING PROGRAMME IN SERBIA



Goat breeding is controlled through the monitoring of fertility, birth weight of kids, body weight, milk yield of Alpine and Saanen goats (Table 1 and Figures 3 and 4). As in other European countries, in Serbia, goats are bred mainly for milk production, and milk yield per head is the most important production characteristic (Pihler et al., 2013). (Source: Pihler, 2014)

FIGURE 3. MILK PRODUCTION OF DIFFERENT GOAT BREEDS IN SERBIA, 2013

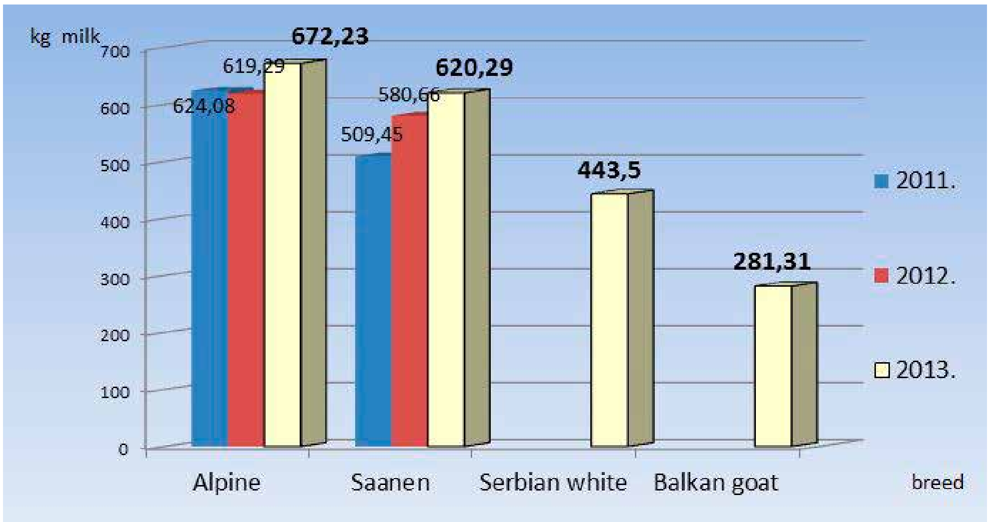
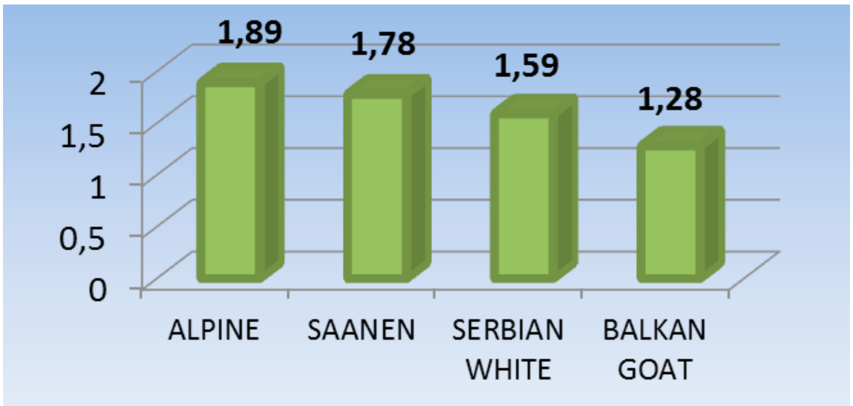


TABLE 1. FINDINGS FROM GOAT MONITORING UNDER THE SERBIAN BREEDING PROGRAMME, 2013

Parameter	Alpine	Saanen	Serbian white	Balkan
Days of lactation	222.24	299.00	223	234
Fertility (%)	1.89	1.78	1.59	1.28
Milk (kg)	674.66	701.00	443.5	281.31
% fat content	3.74	3.48	3.69	3.85
% protein content	3.11	2.85	3.35	3.51
Birth weight (kg)	4.18	3.75	2.61	2.35
Body weight of adults (kg)	64.66	60.25	44.04	41.31

The fertility of goats is calculated as the ratio between the number of kids and the number of kidding (Figure 4).

FIGURE 4. FERTILITY OF DIFFERENT GOAT BREEDS IN SERBIA



Conclusions

In Serbia, especially in the northern Autonomous Province of Vovodina, interest in goat production is increasing. This is primarily because of the high demand for products made from goat milk and meat, and because of the geographical position and terrain of Vojvodina, which allow for the breeding of highly productive goats.

Goat production in Serbia is rising, but the total number of goats is still very small.

In future years, the main herd is expected to grow slightly more quickly as the number of young farmers opting for intensive goat breeding is increasing.

Acknowledgements

The Provincial Secretariat for Science and Technological Development of AP Vojvodina supported the New Technologies to Increase Reproductive Efficiency of Ruminants project.

The Ministry of Education, Science and Tehnology Development of Serbia supported the Use of New Biotechnological Solutions for Breeding Cattle, Sheep and Goats to Produce High-Quality and Healthy Food project.

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ASSESSMENT OF GENETIC DIVERSITY IN DOMESTIC BALKAN GOAT ECOTYPES IN THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

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Abstract

Principal component analysis (PCA) and cluster analysis were performed to describe and understand the extent of genetic variability in domestic Balkan goat ecotypes from The former Yugoslav Republic of Macedonia. In this study, goat ecotypes from ten different farms/locations were analysed to determine the uniqueness of the domestic Balkan goat breed and evaluate the level of diversity among ecotypes. A total of 1 129 animals of both sexes were characterized according to 18 qualitative traits. The frequencies of each analysed trait for each ecotype were determined and used in PCA and cluster analysis. The first two principal components explained 94 percent of the total variance in this data set. All ecotypes except ecotypes 5 and 6 were significantly correlated with principal component 1 (PC1). These findings were confirmed by cluster analysis. Based on the obtained results, two main clusters were identified. The first cluster comprised ecotypes 5 and 6 while ecotypes in the second cluster were classified into two subclusters. This study provided initial information on the extent of genetic variability in Balkan goat ecotypes from the country. However, for better characterization and assessment of genetic diversity in the analysed goat population, further evaluation is recommended, based on both morphological and molecular markers.

Key words: goat ecotypes, genetic variability, principal component analysis, cluster analysis

Introduction

In The former Yugoslav Republic of Macedonia, the goat sector is one of the branches of livestock that has developed over the last 20 years. The country's long tradition of goat breeding was discontinued in 1947 (by a law prohibiting goat breeding), when about 500 000 goats were slaughtered. However, a few goats continued to be bred in very remote rural areas (Official Gazette No. 38, 1948). Goat breeding was re-established in 1989 by the Law on Breeding Goats (Official Gazette No. 21, 1989). These actions had a high impact on the goat sector overall, including breeding and selection work, and also contributed to the erosion of goat genetic resources.

The main characteristics of the domestic Balkan goat are its dense, long and coarse hair, which covers the entire body except the head and legs. There are variations in coat colour, which is usually reddish or grey, black, chestnut, brown and patchy, and occasionally white (Memisi et al., 2004). Markovič et al. (2007) emphasize the importance of this coat colour variation in determining strains, with red-brown coated goats being considered representative of the breed. However, these authors also note that reddish/bay, black or even spotted animals can be present.

Given past activities in the sector and the importance of livestock biodiversity, the main aim of this research was to perform phenotypic characterization and evaluation of the domestic Balkan goat in The former Yugoslav Republic of Macedonia to reveal how similar the current native goat population is to the population that was lost and to assess the level of informativeness of phenotypic characterization in determination of animal genetic resources.

Materials and method

Qualitative variables were documented using a questionnaire and visual appraisal of goat types according to FAO's guidance on phenotypic characterization of animal genetic resources (FAO, 2012).

The following qualitative variables were observed: body hair colour (black, white, fawn, grey, patterned, other); the presence of several colours (either clearly separated or mixed); body skin colour (no pigmentation, black pigmentation, other); hair type (glossy, smooth, straight short, strait long, curly rough); hair length (medium 1–2 mm, long > 2 mm); snout pigmentation (no pigmentation, black pigmentation, other); hoof pigmentation (no pigmentation, black pigmentation, other); horns (present, absent); horn shape (straight, curved, spiral, corkscrew); horn orientation (upwards and backwards, sabre shaped, base-separated); orientation of ears (erect, semi-pendulous, pendulous, horizontal); ear pigmentation (pigmented, semi-pigmented, no pigmentation); head profile (straight, concave, semi-convex, convex); wattles (absent, present); beard (absent, present); ruff (absent, present); rump profile (flat, sloping, roofy); and back profile (straight, sloping up towards the rump, sloping, roofy).

In the study, 1 129 animals were characterized – 104 males and 1 025 females – from ten farms. Animals from each farm were considered as a separate ecotype. The frequencies of each analysed trait for each ecotype were used as input variables for principal component analysis (PCA) and cluster analysis. First two components of PCA were used because they explained more than 94 percent of total variance. Multiscale bootstrap resampling was used to estimate the optimal number of clusters for determining the uncertainty in hierarchical clustering (Suzuki and Shimodaira, 2013). The p-values were calculated for each cluster to determine how well the cluster was supported by data. The defined clusters were considered to be strongly supported by data based on approximately unbiased p-values larger than 95 percent after 1 000 bootstrapping replications.

All statistical analyses were performed with packages in the R 3.0.3 statistical software (R Core Team, 2013).

Results and discussion

Studies of native goat genetic resources have been carried out in many countries (Marković et al., 2007; Memisi et al., 2009; Kume, Papa and Xhemo, 2012; Mioč et al., 2008) with the main aim of characterizing the goat genome at different levels.

Based on the analysis of 18 traits in ten goat ecotypes, animals representing ecotypes 5 and 6 were clearly separated from those in the other eight ecotypes. These two ecotypes were significantly correlated with principal component 2 (PC2), while all other ecotypes were correlated with PC1. The cumulative variance explained by these two PCs was 94 percent: PC1 explained 63 percent of total variance and PC2, 31 percent. Results of the PCA are presented in Figure 1. PCA gave indicative differentiation of the analysed ecotypes, separating ecotypes 5 and 6 from the main group.

High variability in the analysed goat ecotypes was explained by PCA, and two clusters were detected for the analysed data using hierarchical clustering. The clusters identified are presented in Figure 2.

Cluster analysis corresponded with and supported the findings from PCA. It also provided additional information on the level of variability among the analysed ecotypes.

Ecotypes 5 and 6 represented one cluster group while the other ecotypes were included in a second cluster, which was divided into two subclusters. These findings suggest that ecotypes 8, 9 and 10 were different from ecotypes 4, 1, 3, 2 and 7, based on the analysed traits.

FIGURE 1. PCA1 AND PCA2 FACTOR LOADINGS FOR QUALITATIVE TRAITS IN ALL TEN ECOTYPES OF THE BALKAN GOAT IN THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

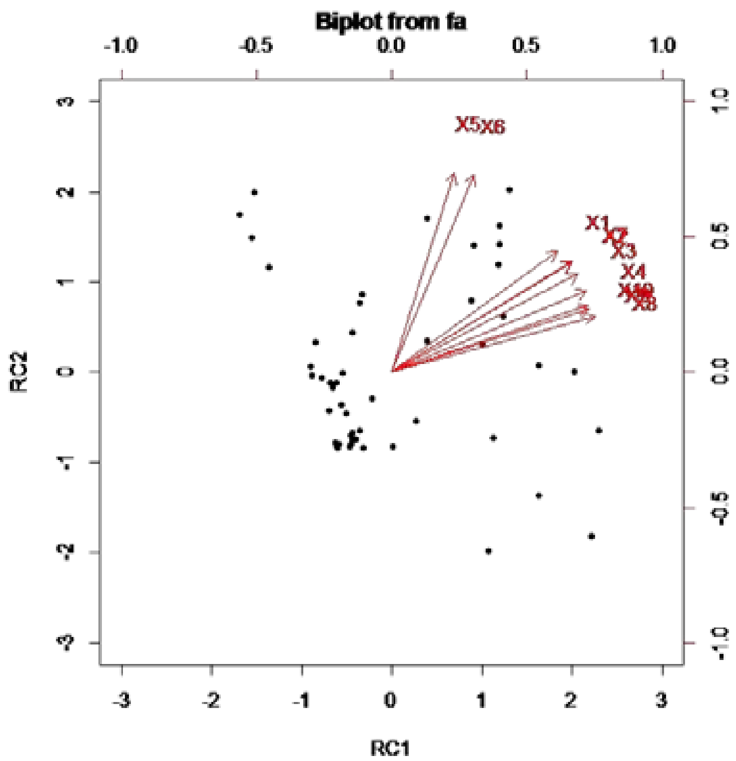
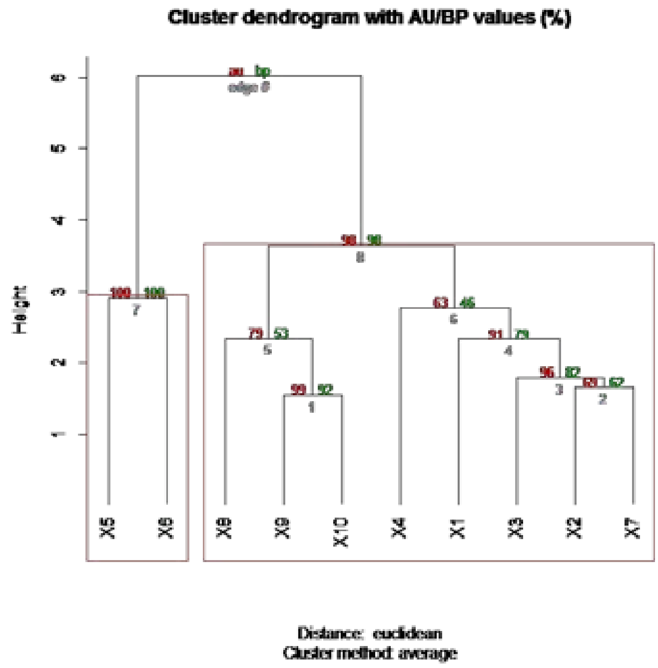


FIGURE 2. DENDROGRAM SHOWING THE CLUSTERING OF THE ANALYSED ECOTYPES



The separation of ecotypes 5 and 6 from the others was based on frequency differences in phenotypic traits such as body skin colour (most animals in ecotypes 5 and 6 were not pigmented and did not have black pigmentation), hair type (straight and short), snout pigmentation (lacking), horn shape (straight), horn orientation (upwards and backwards), ear orientation (erect and carried horizontally), head profile (semi-convex; a low percentage had a straight head profile) and ruff (lacking).

Conclusions

PCA can be used effectively to determine the level of variability and classify the ecotypes that explain most of the variability in the studied population. In this research, the analysed ecotypes were appointed to two PCs based on their qualitative traits: PC1

explained 63 percent of total variance. Goat ecotypes were separated according to their significant correlation with PC1 or PC2.

Hierarchical cluster analysis enabled effective clustering of the analysed goat ecotypes, detecting the presence of two clusters, with two subclusters in the second cluster. This technique provides a clear overview of the level of variability among the analysed goat ecotypes and indicates the presence of two potentially different ecotypes of domestic Balkan goat.

The current population of domestic Balkan goats in The former Yugoslav Republic of Macedonia is characterized by a high level of phenotypic polymorphism. However, the observed phenotypic traits found in analysed ecotypes are very similar to those found in data from the literature on this goat population.

Based on the results of this preliminary research, further genetic characterization of the Macedonian domestic Balkan goat is recommended. Different molecular markers should be applied to evaluate the different levels of variability within and among goat ecotypes and determine the uniqueness of the native goat genome in the country.

Acknowledgements

The authors would like to express their gratitude to the Ministry of Agriculture, Forestry and Water Economy of The former Yugoslav Republic of Macedonia for providing the

necessary funds to realize this study, which is part of the State's annual programme of characterization of the country's livestock biodiversity.

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GOAT BREEDING IN UKRAINE

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Abstract

This paper presents data on the state of goat breeding in Ukraine. The dynamics of the goat population, its distribution across the country's regions and the prospects for goat productivity and development are analysed. Breed composition is investigated, and four main breeds are identified as promising.

Key words: goat, state of goat breeding, livestock numbers, productivity

Introduction

Goat breeding is currently one of the most promising sectors of agricultural business. In the world, there are more than 990 million goats; over the past 50 years, their number has increased 2.5-fold, and almost threefold in North and South America and Africa. Annual world production of goat milk is more than 15 000 tonnes. In some European countries, the share of goat milk is about 30 percent of total milk production; in Near Eastern countries it is 58 percent. However, in Ukraine, the equivalent figure is only 3 percent.

Materials and method

Positive trends of goat numbers and goat milk production volumes indicate the growing popularity of goat products. It should be noted that the number of goats in Europe has decreased slightly in recent years, but goat milk production has increased significantly because of goats' increasing milk yields.

The global population of meat goats is constantly increasing, with especially rapid increases in specialized meat breeds and hybrids of specialized meat and local goats. According to experts, the number of goats reared for meat has increased from 314 to 404 million heads. It is clear that the quality of goat meat is much higher than that of other goat products. However, in European countries, the production of goat meat remains unchanged. The aim of this study was to analyse the situation of goat breeding in Ukraine. Because most goats are kept by households, special methods of calculation were used.

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Results and discussion

Goat breeding is popular in Ukraine. In recent years, the goat population has ranged from 630 000 to 660 000 heads. Currently, most goats (664 800 heads) are kept by households, with only 5 400 heads (1 percent) on larger farms (State Statistics Service of Ukraine, 2012). There is an increasing trend in the number of goats in all categories (Table 1).

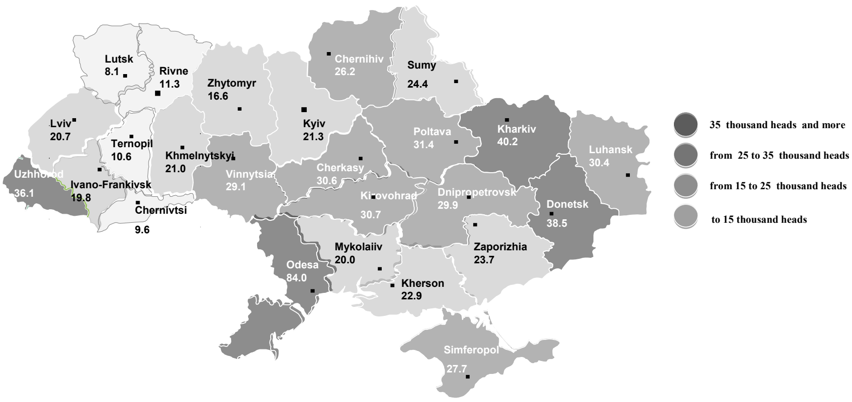
TABLE 1. DYNAMICS OF GOAT NUMBERS IN UKRAINE, 1961–2013

Years	Total amount		Households		Agricultural enterprises	
	Thousand heads	% of number in previous decade/year	Thousand heads	% of number in previous decade	Thousand heads	% of number in previous decade
1961	568.6	86	567.8	86	0.8	15
1971	357.4	54	357.3	54	0.1	2
1981	235.8	35	235.6	36	0.2	4
1991	522.5	79	521.1	79	1.4	26
1996	889.3	134	886.7	134	2.6	48
2001	911.9	137	911.0	138	0.9	17
2006	757.3	114	755.2	115	2.1	39
2010	635.5	96	632.7	96	2.8	52
2011	631.2	95	627.7	95	3.5	65
2012	646.2	97	642.0	97	4.2	78
2013	664.8	100	659.4	100	5.4	100

Goats are kept throughout Ukraine, but most are in the Odessa (84 000 heads), Kharkov (40 200 heads), Donetsk (38 500 heads) and Zakarpattia (36 100 heads) regions

(Figure 1). The Kiev region has the largest number of farms breeding goats (State Statistics Service of Ukraine, 2013).

FIGURE 1. GOAT NUMBERS IN UKRAINE, BY REGION



The highest growth in goat farming on household farms in recent years has been in the western region of the country.

There are only two breeding farms in Ukraine, each keeping about 300 female goats. An additional five farms may be categorized as breeding because of the number of goats they keep, their performance and the level of selection they carry out (Table 2).

TABLE 2. GOAT NUMBERS AND PRODUCTIVITY IN LEADING AGRICULTURAL ENTERPRISES IN UKRAINE

Parameter	Agricultural enterprises						
	Dobrynia	Zolota Koza	Babyni Kozy	Gobzov	Ot Derezy	D'Elise	Chysti kliuchi
Goats	360	320	280	130	95	450	120
Females	160	140	160	41	40	180	60
Milk yield (kg/female/lactation)	700–900	700–900	700–900	650–900	600–900	650–900	550–700

Two breeding farms (Dobrynia and Zolota Koza) together have about 700 heads of different sexes and age groups, accounting for less than 0.1 percent of the country's total goat population.

Ukrainian goats, which are mainly dairy or combined dairy and meat animals, have average daily milk yields of 3.5–8 litres. Live weights are 50–60 kg for females and 70–120 kg for males. Lactation lasts 210–300 days, with a milk yield of 550–900 kg and a milk fat content of 3.3–4.5 percent. Saanen is the most popular breed among goat farmers, and is used to increase the milk production of local goats. The Saanen breed in Ukraine was formed from genotypes imported from Europe.

As a result of unsystematic breeding of Saanen goats, with no organized introduction of breeding materials from abroad, Ukrainian Saanen goats have different exterior characteristics and productivity levels from those of the original breed.

To develop dairy goat farming adapted to the different climatic zones of Ukraine, it is necessary to have more genotypes for breeding and cross-breeding. Worldwide, there is very wide variety in dairy goat breeds. Based on experience, some promising goat breeds have been identified as the most suitable for Ukrainian conditions: Saanen, Alpine, Anglo-Nubian, Toggenburg and other European breeds and types (Novopashyna, 2013).

A wide range of goat products are produced in Ukraine, especially soft and hard goat cheese (about ten varieties), which are in very high demand. The production of some household farms has won awards at agricultural exhibitions, including international ones. A wide range of products – milk, cheeses, sour cream, butter, yoghurt, cream, fat, meat, etc. – are sold in shops, restaurants, hotels and directly to consumers, but the range of domestic products is smaller than that available in Europe as a whole.

The market for goat meat products is not developed in Ukraine, but there is potential for the development of goat breeding for meat in the future.

Ukrainian people appreciate the advantages of goat products, but their high prices mean that many people cannot afford them. In rural areas, goat milk is sold at the same prices as cow milk, but in the cities it costs two to three times as much, and is sometimes five times more expensive.

Based on the current situation, goat farming is likely to see:

- increased numbers of farms with 100–2 000 heads;
- increased numbers of high-performing pedigree animals;
- increased goat productivity;
- reduced production costs.

The main obstacles that significantly impede the development of goat breeding are the low productivity of animals, limited access to the best international genotypes, the absence of state support, and the need for controlled breeding.

Conclusions

It can be concluded that Ukraine needs to increase its organization of goat breeding. Breeding stock and semen of modern breeds should therefore be imported in the near future. This could be arranged via the existing breeding centre, which could lead to selection work using imported animals. It will be very important to organize an efficient system of data collection and pedigree recording of goats. The Ivanov Institute of Animal Breeding for the Steppe Regions "Askania Nova" has the best potential for this activity.

There is also need for state support of goat breeding. This could take the form of preferential loans, reimbursement of maintenance costs and purchases of breeding animals, preferential leasing of equipment and other measures.

Acknowledgements

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POPULATION STRUCTURE OF SOUTH AFRICAN COMMERCIAL DAIRY GOATS

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Abstract

The aim of this study was to evaluate the population structure of South African commercial dairy goats, for genetic management and as a genetic resource for improving the local goat populations used for household milk production. In South Africa, the dairy goat population numbers fewer than 4 000 registered animals and is comprised mainly of the exotic Saanen, Toggenburg and British Alpine breeds. The dairy goat industry is characterized by fragmented organizational bodies and limited recording, but serves a niche market. This study was based on 4 023 Saanen, 579 Toggenburg and 597 British Alpine pedigrees collected since 1955, 1960 and 1970 respectively. Average inbreeding coefficients (F) calculated were 0.0623 for Saanen goats, 0.1335 for Toggenburg goats and 0.0993 for British Alpine goats. Effective population sizes (Ne) were 341, 63 and 53 and rates of inbreeding (ΔF) were 0.0146, 0.0857 and 0.0451, respectively in the Saanen, Toggenburg and British Alpine populations. The resultant population parameters suggest that there is sufficient variation in the South African Saanen, Toggenburg and British Alpine populations to exploit them for the improvement of the local goat population.

Key words: inbreeding, pedigree, effective population size

Introduction

FAO estimates that the South African goat population consists of about 6.2 million animals (FAO, 2012), of which an estimated 63 percent are unimproved indigenous goats in the non-commercialized agriculture sector (Directorate: Marketing, 2012). Commercial dairy goats are a minority, with fewer than 4 000 registered with the South African Stud Book.[35] Commercial dairy goats in South Africa belong to the Saanen, Toggenburg and British Alpine breeds. These exotic breeds are preferred for commercial milk production because of their higher and more reliable production levels. Saanen goats were first imported to South Africa in 1898, the Toggenburg was imported in the early twentieth

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century and the British Alpine imported between 1924 and 1934 (Olivier et al., 2005).

Registration data obtained from the South African Stud Book indicate that there is growing interest in keeping and breeding dairy goats. The Saanen is the most popular breed, and 488 of the kids born in 2012 were registered. Registrations were low during the 1990s, with fewer than 60 animals registered per year, but have increased since 2004. British Alpine and Toggenburg goats are much fewer in number, but registrations of these breeds have gradually increased since 2000.

Previous studies found that South African indigenous goats produce an average of 23 kg of milk per lactation of 93 days, while Saanen goats can produce more than 700 kg per lactation of 288 days (Donkin and Boyazgolu, 2000). The South African goat lactation season runs from 1 September until 31 of August of the following year (Muller, 2005). Table 1 shows milk production from commercial breeds, which is much higher than the available lactation data for indigenous goat types.

TABLE 1. LACTATION STATISTICS FOR COMMERCIAL DAIRY GOAT BREEDS IN SOUTH AFRICA, 2012/2013 SEASON

Breed	Lactations recorded	Average milk yield (kg)	Average protein content (%)	Average fat content (%)	Average days of lactation
British Alpine	45	1366	3.6	5.0	202
Saanen	85	1227	3.2	4.0	317
Toggenburg	30	1297	3.6	4.9	215

Source: South African Stud Book.

Over the intervening years of milk goat breeding, the original founder animals have most likely not remained pure and have been bred with other dairy-type goats (Muller, 2005). Genetic material cannot be readily exchanged with other major centres of dairy goat production because of the distances and other issues, including outbreaks of diseases such as foot-and-mouth disease and the prevalence of endemic diseases. South Africa is free of scrapie (Directorate: Agricultural Information Services, 2003), and importing live goats from areas where scrapie is endemic is therefore prohibited. By keeping the limited stock pure, there is a risk that the gene pool becomes too small through inbreeding. Additional pure stock has been imported from time to time, but the loss of genetic diversity is a potential threat because of the relatively small population sizes.

The majority of commercial dairy goats in South Africa are kept by a few large producers, with the remainder in smallholder systems with herds rarely exceeding 100 animals. The dairy goat industry is fragmented, with producers divided between those breeding stud animals – represented by the South African Milch Goat Breeders' Society[36] – and producers who wish to breed only for the sake of production, and do not necessarily breed stud animals. These producers are represented by the Southern African Goat and Sheep Milk Processors' Organization, which also certifies the goat milk products produced by its members, provided that the products are produced from goats that are at least seven-eighths Swiss-type dairy goats. This condition accommodates commercial farmers who use cross-breeding practices to improve the butterfat content of their milk, usually by crossing Saanen with Toggenburg. The F1 generation is however crossed back to one of the parent breeds or to a third breed, such as the British Alpine. It should be noted that the commercial production situation in South Africa is similar to that described by Dýrmundsson (2006): dairy goats and their products are not normally the primary source of income for producers, but are rather an addition to other farming activities or are even completely unrelated to the producer's primary source of income.

36 www.milkgoats.co.za/milkgoat_society/index.php

Most registered goats are stud animals, and this fact should be considered when estimating the total number of dairy goats in South Africa. Commercial animals used purely for production purposes are generally not registered, and the recording of pedigrees among commercial farmers is frequently poor or non-existent. Dairy goats are also included in the National Dairy Improvement Scheme along with dairy cattle (Olivier et al., 2005), but participation by dairy goat producers is poor.

Dairy goat products occupy a niche market in South Africa. Goat milk is often used as a replacement when infants or adults display allergic reactions to cow milk (Haenlein, 2004). Many producers focus on manufacturing cheeses and other value-added products. Most marketing of these products is informal, such as through direct sales to consumers at the farm or at fresh food, organic or farmers' markets. Limited quantities of local goat milk products are sold through retailers and supermarket chains, and it is difficult to estimate the true volumes of milk produced. Unfortunately, goat milk production is highly seasonal in South Africa. Out-of-season demand is satisfied by importing powdered goat milk (Directorate: Animal Production, 2007). As most trade is informal, there are no official milk production figures, but unofficial estimates suggest that South African goat milk production is about 1.4 million tonnes/year (Directorate: Animal Production, 2007).

The aim of this study was to determine the population structure of the South African Saanen, Toggenburg and British Alpine populations from available pedigree records, for genetic management and as a genetic resource for improving the local goat populations used for milk production.

Materials and method

Pedigree records dating back to 1955 for Saanen (4 023 animals), 1960 for Toggenburg (579) and 1970 for British Alpine (597) goats were obtained from the South African Stud Book. The information recorded included individual animal registration numbers, farm identification numbers and names, dates of birth, gender, the registration numbers of sires and dams, and whether the animal was alive when the records were requested. The herd books of Saanen, Toggenburg and British Alpine goats are all managed as open resources, and may include any animal that has been approved for registration by the South African Milch Goat Breeders' Society. New registrations often lack complete pedigree records. Stud animals are more likely to be registered, while strictly commercial goats are rarely registered.

The software POPREP (Groeneveld et al., 2010) was used to analyse the population structure of the breeds from the available pedigree records. This software analyses data in terms of cohorts, with animals grouped according to year of birth and as to whether they have been selected as replacement stock. This system allows determination of the numbers of breeding males and females in a given year, and the age structure of parent goats. The age structure of the parents is also useful in determining the generation interval, while the distribution of parity indicates the time that an animal remains in the herd before being culled.

POPREP also analyses pedigree quality by taking into consideration the completeness of the pedigrees and producing a pedigree completeness index (PCI) (Groeneveld et al., 2010). The PCI summarizes the known ancestors in each previous generation. POPREP assumes that animals with unknown parents are unrelated, and the PCI value decreases as a pedigree's completeness decreases. The probability of detecting inbreeding in a population therefore decreases with the PCI value, as such records are incomplete.

POPREP determines the effective population size (Ne) through several different methods. One of these methods uses a defined number of generations and takes into account the number of breeding males and females used each year. The Ne for a specific year is then calculated by considering the number of breeding animals used during the previous generation interval (Groeneveld et al., 2010). Another method makes use of the inbreeding rate of change per year (ΔF). The Ne will vary depending on whether the entire population (breeding and non-breeding animals) is used to calculate ΔF, or only the parents of successive generations.

The POPREP software is also used to calculate the inbreeding coefficient F and the ΔF. The ΔF is calculated from the inbreeding coefficient of a cohort born in a given year, using either the F of all the parents of the given cohort or the F of another cohort born a generation earlier, as calculated using the generation interval (Groeneveld et al., 2010). This is done for each year.

Results

The average generation intervals for the three breeds were quite similar, at 3.2 years for the British Alpine, 3.4 for the Saanen and 3.9 for the Toggenburg. The average age of breeding bucks and dams thus varied from 3.9 years for the Toggenburg to 3.2 years for the British Alpine, as shown in Table 2. The family sizes of sires were much larger than those of dams, with sires having higher numbers of offspring than dams (Table 2).

TABLE 2. COMPARISONS OF AVERAGE GENERATION INTERVALS, BREEDING AGES AND FAMILY SIZES OF SAANEN, TOGGENBURG AND BRITISH ALPINE GOATS IN SOUTH AFRICA

Breed	Generation interval			Breeding age		Family size	
	♂	♀	Average	♂	♀	♂	♀
Saanen	3.5	3.4	3.4	2.0	1.9	5.9	1.9
Toggenburg	4.1	3.7	3.9	2.8	3.0	3.8	1.6
British Alpine	2.8	3.5	3.2	2.1	2.1	4.6	1.8

Table 3 shows the number of parities over the recording period for Saanen, Toggenburg and British Alpine does. There is a sharp decline in does remaining in the herd past their second parity, while no doe has had more than eight parities.

TABLE 3. PARITY NUMBERS FOR ALL RECORDED SAANEN, TOGGENBURG AND BRITISH ALPINE DOES IN SOUTH AFRICA, 2012

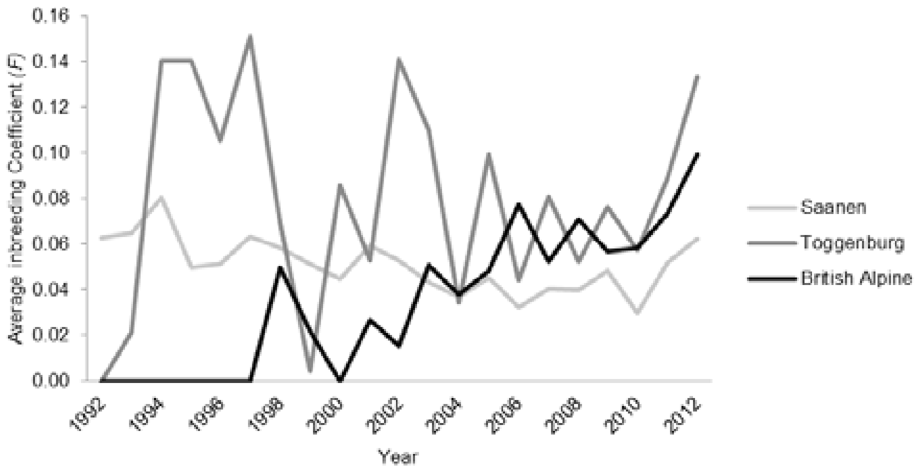
Parity	1	2	3	4	5	6	7	8
Saanen	1 746	467	129	44	14	6	3	1
Toggenburg	271	61	24	3	0	0	0	0
British Alpine	271	85	36	11	4	2	1	0

The first-generation pedigree records of the Saanen, Toggenburg and British Alpine were 100 percent complete in 2012. The sixth-generation Saanen records were 70 percent complete, while the pedigree records of the 4 013 animals were 71 percent complete. The sixth-generation records of the Toggenburg goats were 73.6 percent complete, with an overall completeness of 73 percent; the overall completeness of the British Alpine records was 83 percent. The effective population size (Ne) was calculated by considering the number of breeding animals in the previous generation interval. It was found that the Ne of the Saanen was 341, that of the Toggenburg was 63 and that of the British Alpine 53.

In 2012, it was found that the rates of inbreeding change per year (ΔF) were 0.0146, 0.0857 and 0.0451 respectively in the Saanen, Toggenburg and British Alpine. Of the 488 Saanen born in 2012, 347 were deemed inbred, with an average inbreeding coefficient

(F) of 0.0623 ± 0.0759 across the whole Saanen kid crop of 2012. These were the offspring of 41 inbred sires (F = 0.0642) and 152 inbred dams (F = 0.0460). The maximum F found was 0.3471. In the same year, 22 Toggenburg kids were born, of which 17 were considered inbred (F = 0.1335 ± 0.1063). All four of the 2012 sires were considered inbred (F = 0.1222), while 12 of the 18 dams had an average F value of 0.1058. The maximum F value seen in the 2012 Toggenburg crop was 0.4043. In the British Alpine, 89.7 percent of the 78-strong kid crop was considered inbred (F = 0.0993 ± 0.0705). Seven of the nine sires were considered inbred (F = 0.0799), while 31 of the 53 does had an average F value of 0.0606. The maximum F value was 0.3145. The average F value of the Saanen, Toggenburg and British Alpine kids born between 1992 and 2012 are presented in Figure 1.

FIGURE 1. AVERAGE INBREEDING COEFFICIENTS (F) OF THE SAANEN, TOGGENBURG AND BRITISH ALPINE KIDS REGISTERED IN SOUTH AFRICA, BETWEEN 1992–2012



Discussion

The generation intervals for the South African populations of Saanen, Toggenburg and British Alpine goats in this study (3.4, 3.9 and 3.2 years respectively) were similar to those reported for the French Saanen and Alpine breeds (4.0 and 4.1 years) (Danchin-Burge et al., 2012). Only 8.2 percent of the registered Saanen does completed three or more lactations, while 7.5 percent of the Toggenburg and 13.1 percent of the British Alpine does completed three lactations. As the production from dairy goats is normally highest during parity three or four (Goetsch et al., 2011), these figures suggest that the dairy goat population in South Africa is performing below its capacity, and that does are leaving herds too soon.

The official pedigree recording of the Saanen, Toggenburg and British Alpine populations started in the same period as that of South African Holstein, Jersey, Ayrshire and Guernsey dairy cattle breeds (Maiwashe et al., 2006). However, far more pedigree records are available for the dairy cattle population than for dairy goats (with 4 013 Saanen records versus 890 598 Holstein ones). The pedigree completeness of the dairy goat breeds (71, 73 and 83 percent for the Saanen, Toggenburg and British Alpine respectively) was similar to that seen in dairy cattle breeds, where the Guernsey had 70 percent pedigree completeness over its recording period, versus the Jersey with 90 percent (Maiwashe et al., 2006).

The PCI measures the reliability of inbreeding values; animals with unknown parents are assumed to be unrelated to the overall population, and therefore given an inbreeding coefficient of zero (Mucha and Windig, 2009), which may lead to underestimation of the true inbreeding levels in a population. This is of special importance in the South

African commercial dairy goat population, where the three herd books are open, but very few animals are registered.

Of the three breeds, the Toggenburg had the highest rate of inbreeding change per year (ΔF). The Toggenburg ΔF of 0.0857 (8.57 percent) and the British Alpine ΔF of 0.0451 (4.51 percent) far exceeded the FAO guideline for a ΔF of 0.01 (1 percent) (Mucha and Windig, 2009). These levels were also much higher than those seen in the South African dairy cattle breeds, which varied from 0.05 percent to 0.07 percent (Maiwashe et al., 2006); Canadian Holsteins and Jerseys had ΔF of 0.014 percent and 0.011 percent, respectively (Stachowicz et al., 2011). The average inbreeding coefficient seen in the French Saanen population was 2.21 percent (Danchin-Burge et al., 2012), compared with the South African Saanen population's 6.23 percent. The high rate of inbreeding change seen in South African dairy goat breeds is probably because of the increased interest and demand for these animals. Registrations of all three breeds have increased in the last decade, with limited opportunities for introducing new genetic stock, which may have contributed to the increased levels of inbreeding observed in this study. The effective populations (Ne) of the Saanen, Toggenburg and British Alpine populations were 341, 63 and 53 respectively. The dairy cattle breeds in South Africa, despite having much larger populations than the dairy goats, had Ne that varied between 108 and 165 (Maiwashe et al., 2006).

Conclusions

The Saanen, Toggenburg and British Alpine populations in South Africa have increased rapidly in the last few years as interest in dairy goats and their products has grown. This may have contributed to the increased rate of inbreeding seen in these populations. However, estimation of inbreeding in these breeds is complicated by poor recording practices, which means that estimations are based on only a small part of the total commercial population. The resultant population parameters suggest that there is sufficient variation in the South African Saanen, Toggenburg and British Alpine populations to exploit them for improvement of the local goat population.

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EVALUATION OF BODY MORPHOLOGY AND PRODUCTION TRAITS OF GOAT BREEDS IN HUNGARY

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Abstract

The objective of this study was to survey the heterogeneous goat population of Hungary and determine the similarities and differences between local and imported breeds. Typical body measurements and external characteristics were examined and described for Hungarian Milking White (HMW), Hungarian Milking Brown (HMB), Hungarian Milking Multicolour (HMM), Alpine and Saanen does. Monthly test milkings measured milk yields, and milk samples were taken from individual Hungarian goats. Fat, protein and lactose contents were defined in the laboratory. In all examined body measurements, the HMW and Saanen goats and the HMB and Alpine goats were significantly different. Among the five breeds, Saanen does were the heaviest and also had the widest thorax and hip measurements. The highest wither, longest body and deepest thorax measurements were found in the Alpine breed. Among the three Hungarian breeds, HMW had the lowest body weight, wither height, body length and thorax depth, while HMM had the smallest thorax, pelvic and hip widths. All measurements were highest in the HMB breed. HMW and HMB were significantly different from HMM goats. HMM does started lactation with the highest daily yield, while HMW does had the highest average daily yields from the second stage of lactation. Throughout a lactation, the HMB had the lowest daily yield. HMW and HMM does had peak daily yields (1.6 litres) in days 81–110 of the lactation period, while HMB does had their peak daily yield (1.5 litre) in days 111–140. In all three breeds, at the beginning of the milking season, the daily milk yield was 1.4–1.5 litres, increasing to 1.5–1.6 litres in the second stage. The fat content increased from 3.2 to 5.0 percent, with the highest fluctuations in the HMB goats, which produced the highest fat contents at the beginning and end of lactation. The protein content increased from 3.1 to 3.9 percent. In HMW goats, the protein

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content increased persistently, while in HMB and HMM it decreased in the second stage of lactation, increasing again from day 111. The lactose content ranged from 4.3 to 4.6 percent. The highest was in HMW milk and the lowest in HMM, with significant differences at almost all stages of lactation, except for in days 81–110.

Key words: body morphology, milk yield, milk content, local goat

Introduction

The primary aim of Hungarian goat breeding programmes has been to stabilize and standardize local breeds, and to improve productivity by carrying out cross-breeding using imported intensive breeds (Alpine and Saanen).

The easiest and fastest way to identify goat breeds is to describe external markings and measure body characteristics and production traits, rather than to use molecular biology methods (quantitative trait loci, microsatellites , mitochondrial DNA polimorphism analysis). In several countries, local (mainly native) goat breeds have been described over the past few decades, but in Hungary little information is available on the phenotypical markings, body measurements and correlation of these traits with milk production for the breeds that make up 80 percent of the country's goat population. Body measurements of Hungarian goats were published by Bodó in 1959. In 1999, the Hungarian Goat Breeders' Association embarked on the description of external and milk production traits of the three goat breeds in the national breeding programme in response to the growing attention given to preserving the world's biodiversity. Following the cross-breeding of goats to increase milk production, growing numbers of native breeds are disappearing.

The objective of the evaluation was to collect basic data for testing performance and assessing the relationships between performance and breed characteristics. The external markings and milk production traits of Hungarian breeds needed to be examined and described to determine the similarities and differences between native and imported breeds.

The experiments focused on the following questions:

1) What are the typical body measurements of Hungarian goat breeds?

2) What are the average milk production traits of the Hungarian breeds (daily milk yields, milking periods, milk quantities, fat contents, protein contents, lactose contents and somatic cell counts)?

Materials and methods

The first examination surveyed the body measurements (weight, wither height, body length, thorax depth and width, pelvic width, hip width, head length, ear length and width and distance between eyes) of does of the milking breeds kept in Hungary: 198 Hungarian Milking White (HMW), 182 Hungarian Milking Brown (HMB), 202 Hungarian Milking Multicolour (HMM), 146 Alpine and 216 Saanen does were assessed. Monthly test milkings measured milk yields, and milk samples were also taken from individual Hungarian goats (187 HMW, 203 HMB and 143 HMM). In laboratory examinations, the fat, protein and lactose contents of the milk and the somatic cell count were defined.

The SPSS 15.0 software package was used for statistical analysis. The least squares means ± standard error of mean of each parameter were calculated to enable comparisons among data and to demonstrate differences. Pearson-correlation analysis was used to define relations among body measurements, while multivariate analysis of variance was applied to compare the breeds and identify the effects of breed, age and farm.

Results

The HMW and Saanen and the HMB and Alpine goats were significantly different in all the body measurements examined. Among the five breeds, the Saanen does were the heaviest and had the widest thorax and hip measurements. The highest wither, longest body and deepest thorax measurements were found in the Alpine breed. The average body weight, wither height, pelvic and hip width of Alpine and Saanen breeds were significantly different, but the differences in body lengths and thorax depths between these two breeds were not statistically justified. Among the three Hungarian breeds, the HMW had the lowest body weight, wither height, body length and thorax depth, while the HMM had the smallest thorax, pelvic and hip widths. All measured data were highest in the HMB breed. The body weight and length and the thorax depth and width of HMB were statistically different from those of HMW and HMM goats, while there were no significant differences in wither heights among the three breeds. HMW and HMB were significantly different from HMM does, while the differences in average hip width between HMB and HMM were statistically proven (Table 1).

TABLE 1. LEAST SQUARES MEANS ± STANDARD ERROR OF MEAN OF BODY MEASUREMENTS OF GOAT BREEDS IN HUNGARY

Breed n	HMW 198	HMB 182	HMM 202	Alpine 146	Saanen 216
Body weight	46.28 ± 0.64a	48.97 ± 0.67b	46.61 ± 0.64a	52.59 ± 0.75c	56.10 ± 0.62d
Wither height	64.62 ± 0.31a	65.16 ± 0.32a	64.73 ± 0.31a	67.62 ± 0.36b	66.22 ± 0.30c
Body length	69.15 ± 0.32a	70.52 ± 0.34b	69.34 ± 0.32a	73.73 ± 0.38cd	73.20 ± 0.31d
Thorax depth	30.53 ± 0.18a	31.21 ± 0.18b	30.71 ± 0.17a	32.15 ± 0.20cd	31.80 ± 0.17d
Thorax width	18.06 ± 0.18a	18.70 ± 0.19b	18.00 ± 0.18a	19.62 ± 0.21c	20.62 ± 0.17d
Pelvic width	16.24 ± 0.11a	16.31 ± 0.11a	15.86 ± 0.11b	16.98 ± 0.13c	17.69 ± 0.10d
Hip width	17.58 ± 0.10a	17.78 ± 0.10ab	17.37 ± 0.10ac	18.40 ± 0.11d	19.02 ± 0.09e
Head length	16.97 ± 0.08a	17.24 ± 0.09bc	17.02 ± 0.08ac	17.42 ± 0.10b	17.57 ± 0.08b
Ear length	13.53 ± 0.19a	13.51 ± 0.20a	13.24 ± 0.19a	14.34 ± 0.23b	14.26 ± 0.19b
Ear width	6.73 ± 0.10a	6.91 ± 0.10a	6.79 ± 0.10a	7.27 ± 0.11b	7.41 ± 0.09b
Distance between eyes	12.56 ± 0.07a	12.85 ± 0.08b	12.78 ± 0.07b	12.85 ± 0.09b	13.24 ± 0.07c

a, b, c, d, e: Different superscripts in a row means significant differences ($P \leq 0.05$)

The HMM does started lactation with the highest daily yield, while from the second stage of the lactation, the HMW does had the highest average daily yield. Throughout a lactation, the HMB does had the lowest daily yield. The HMW and HMM does had their peak daily yields (1.6 litres) in days 81–110 of lactation, while the HMB's peak daily yield (1.5 litres) was in days 111–140. At the beginning of the milking season, the daily milk yield was between 1.4 and 1.5 litres, increasing to 1.5–1.6 litres in the second stage in all three breeds. The yield stayed at the same level in the HMW and HMM breeds, decreasing to 1.0 litre in days 171–200 at the end of lactation. The milk production of HMB does decreased to 0.9 litres after the peak yield.

The fat content of the milk increased from 3.2 to 5.0 percent, with the highest fluctuation in the HMB does, which produced the highest fat content at the beginning and end of lactation.

The HMM does produced 3.4 percent milk fat until day 170, when it increased strongly. The tendencies were similar in the other two breeds, but the fat content increased from 3.3 to 3.5 percent in the HMW does, remaining stable until day 200 and then increasing strongly.

The protein content of the milk increased from 3.1 to 3.9 percent. In the HMW does the protein content increased persistently, while in the HMB and HMM does it decreased from the second stage of lactation, reincreasing again from day 111.

During the lactation period the differences among breeds changed: until day 140, the protein yield was highest in HMM does, switching to the HMB does in later stages.

During the milking period, the lactose content of the milk ranged from 4.3 to 4.6 percent. The highest lactose content was measured in HMW and the lowest in HMM milk, with the differences being significant in almost all stages of lactation except for days 81–110. In the two last stages of lactation, the lactose contents of HMW and HMB milk were significantly different.

The somatic cell count increased continuously during lactation, with values at the end being three times those at the beginning. The highest increase (fourfold) was in the HMB breed. The somatic cell count was highest in HMB does until day 230, when it switched to the HMW does.

Discussion

The one-year-old Hungarian does were heavier than those measured by Bodó in 1959, but the two-year-old does had similar body weights. At three years of age, the body weight of does kept in Hidashát (Hungary) was higher than that measured in the does in this study. The three-year-old does in this study were smaller and shorter than the does measured by Bodó. The correlations among body measurements were compared with those of native breeds in other countries. The correlation between body weight and wither height in Alpine does was similar to results published by Kafidi et al. in 2000, but the correlation in Saanen does was stronger than that in these earlier results. In the three Hungarian breeds, the correlations among body measurements were similar to those found in Creole goats (Vargas, Larbi and Sánchez, 2007). The correlation coefficients of the relationship between body weight and body length were between the results found in West African Dwarf goats (Samuel Fajemilehin and Salado, 2008) and those found in Beetal goats (Khan et al., 2006). The correlation coefficients of body length and wither height of HMB and Alpine does were similar to those found in Nigerian Red Sokoto goats (Hassan and Ciroma, 1992), while in HMM and Saanen goats the correlations were not as strong as those described in West African Dwarf goats (Samuel Fajemilehin and Salado, 2008).

The average daily yields of the three Hungarian breeds were lower than those previously published for these breeds (Kukovics, 2005). The peak daily yields were reached later, but where higher than in Creole goats (Alexandre et al., 1997).

The fat content of milk ranged from 3.2 to 5.0 percent, as in the Camosciata breed (Mimosi et al., 2007). An important increase in fat content from April to December was observed in Andalusia (Mena et al., 2007). Similar fat contents to those found in this study (3.7 percent) were found in Greece (Katanos et al., 2005) and Morocco (Zantar et al., 2008).

The changes in protein content (from 3.1 to 3.9 percent) during lactation where similar to other findings (Mena et al., 2007). The average daily protein content during lactation (3.3 percent) was similar to those found in Red Syrian (Claps et al., 2007) and Camosciata breeds (Mimosi et al., 2007).

The changes in lactose content (ranging from 4.3 to 4.6 percent and averaging 4.4–4.5 over the lactation period) were similar to those found in Greece (Katanos, Skapetas and Laga, 2005).

Increasing somatic cell counts during the milking period were also found by other authors, but the rates of increase varied. This study found somatic cell counts increasing from 867 000 to 3.3 million, which was similar to the results published for Alpine, Saanen, Nubian and Toggenburg breeds (Sung, Wu and Wang, 1999).

The somatic cell counts at the end of the lactation period were three or four times those measured at the beginning, which is similar to results found in Italy (Rosati et al., 2005). Values at the end of lactation were higher than those published for Italy (Rosati et al., 2005). Over the milking period, the somatic cell counts averaged 1.7–1.9 million, while the differences were wider in Greece (Anifantakis et al., 1996).

Conclusions

According to the analysis of body measurements, it can be concluded that does of Hungarian breeds were mated too early, before attaining full growth, and therefore remained smaller and produced less milk. It could be recommended that the milking period start as soon as possible after kidding, with the dry season starting after 200 days, when milk yields decrease even though fat and protein contents increase. According to the results of this evaluation, separating the Hungarian goat population into three breeds depending on coat colour seems to be justified, so maintenance of the three individual breeds is reasonable. The results of this analysis of the three Hungarian breeds could provide the basis for further study of the genetic background for the differences and/or similarities among the three breeds.

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GENETIC VARIABILITY OF LIPOGENIC ENZYMES (DGAT2, SCD) AND GLYCOPROTEIN (BTN1A1) IN THE DAIRY GOAT POPULATION OF THE CZECH REPUBLIC

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Abstract

Enhancing milk productivity, yield and composition are of great economic importance for the dairy goat industry. They are influenced by multiple genes or quantitative loci (QTL) dispersed across the genome, and by an array of different environmental factors. The aim of this study was to investigate the variation/genetic polymorphism in the lipogenic enzymes DGAT2 and SCD and the glycoprotein BTN1A1 in the dairy goat population of the Czech Republic. Typing of the DGAT2, SCD and BTN1A1 loci was performed by polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP). Molecular analysis confirmed the polymorphic site in exon 4 at position 216A > G and revealed that the most prevalent genotype was GG (76.09 percent) followed by AG (21.30 percent) and AA (2.61 percent) at the BTN1A1 locus in the studied goat population. The frequency of allele B (82.24 percent) and genotype BB (71.71 percent) predominated over allele A (14.47 percent) and genotypes AA (1.97 percent), AB (21.05 percent) and AC (3.95 percent), and allele C (3.29 percent) and genotype CC (1.32 percent) in the region of exon 3 and intron 3 at the SCD locus in the studied goat population. No polymorphism was detected in exon 4 at the DGAT2 locus. This information on genotype variability in the dairy goat population could be exploited in breeding programmes aiming to preserve biodiversity or improve the quality of processed milk from Czech goat breeds.

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Key words: goat, lipogenic enzymes, polymorphisms

Introduction

Milk production traits are polygenic. The genes affecting them are difficult to identify, but a few potential candidate genes have been recognized (Ibeagha-Awemu, Kgwatalala and Zhao, 2010).

Milk fat is an important component of the nutritional quality of dairy goat products. The fat content and composition of goat milk can be extensively modified by genetic, physiological and nutritional factors (Chiliard et al., 2003).

Single nucleotide polymorphisms (SNPs) are a class of direct markers that locate the loci that code for functional mutation more effectively than other markers such as linkage disequilibrium (LD) with functional mutations and population-wide linkage equilibrium (LE) markers. Analysis of marker–trait associations can bring significant improvement of polygenic traits such as milk yield, growth, meat production and reproduction (An et al., 2011; Qu et al., 2011; Rychtářová et al., 2014).

The stearoyl-CoA desaturase (SCD) gene encodes an integral membrane protein of the endoplasmic reticulum that plays a central role in the synthesis of mono-unsaturated fatty acids (MUFAs) (Ntambi and Miyazaki, 2004). Several SNPs have been identified, some of which are significantly associated with growth traits in Chinese goat breeds (Zhang et al., 2010; Chen et al., 2011) or with milk traits (Crepaldi et al., 2013).

Diacylglycerol acyltransferases 2 (DGAT2) plays an essential role in catalysing the final step of the triacylglycerol (TAG) biosynthesis of the Kennedy pathway (Weiss, Kennedy and Kiyasu, 1960; Bell and Coleman, 1980; An et al., 2011). Some of the SNPs determined in a goat species have been associated with production or growth traits (An et al., 2011; Fang et al., 2012).

Butyrophilin (BTN1A1) is a transmembrane glycoprotein expressed especially on the apical surface of mammary epithelial cells in the final stage of pregnancy and during lactation. It is also the primary protein in the membrane surrounding fat droplets in milk (Mather, 2000). Recent studies have shown that the functional protein BTN1A1 is necessary for the proper secretion of milk components, especially fat (Ogg et al., 2004; Komisarek et al., 2006). BTN1A1 also influences fertility parameters in cattle (Rychtářová et al., 2014). To date, one SNP BTN1A1 gene has been identified and is significantly associated with milk production traits in goat species (Qu et al., 2011).

The aim of this study was to investigate variation – genetic polymorphism – in lipogenic enzymes DGAT2 (C234A) and SCD (315G > A, 68A > G and 55A > G) and glycoprotein BTN1A1 (218C > T) in the dairy goat population of the Czech Republic.

Materials and methods

Genomic DNA samples were obtained from 230 White Shorthaired, Brown Shorthaired and cross-bred goats. DNA was extracted from the blood using the ABI PRISM 6100 Nucleic Acid PrepStation instrument (Applied Biosystem Co., USA) according to the standard protocol. Genotypes of the DGAT2, SCD and BTN1A1 loci were determined through polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) (Table 1). The amplification products and restriction patterns were made visible on agarose gel (PCR-agarose, Top-Bio, CR) in Tris/Borate/EDTA (TBE) buffer stained with ethidium bromide.

Sequence analysis (ABI PRISM 3130 – Genetics Analyzer) was used to confirm the described SNPs at the DGAT2, BTN1A1 and SCD loci in studied regions. The sequences were aligned by nucleotide database of the National Center for Biology Information (NCBI) of the United States of America.

PowerMarker data analysis software (Liu and Muse, 2005) was used to estimate allele and genotype frequencies, gene diversity, heterozygosity and the polymorphic information content (PIC) value and to verify the Hardy-Weinberg equilibrium.

TABLE 1. ANALYSES APPLIED TO THE DNA SAMPLES FOR GENOTYPING AT BTN1A1, DGAT2 AND SCD LOCI IN CZECH DAIRY GOAT BREEDS

Locus	Methods	Region	SNP	Product size	Reference
DGAT2	PCR-RFLP	exon 4	ex_4, 234C > A, Leu > Met	344 bp	An et al., 2011
BTN1A1	PCR-RFLP	exon 4	216A > G Gln > Lys	459 bp	Qu et al., 2011*
SCD	PCR-RFLP	exon 3,	ex_315G > A, Met > Val ex3_68A > G	362 bp	Chen et al., 2010
		intron 3	IVS3 + 55A > G		

* Method optimized to conditions.

Results and discussion

Allele frequencies and genotype distribution, gene diversity and heterozygosity, polymorphism information content (PIC) and Hardy-Weinberg equilibrium at the BTN1A1 and SCD loci of the examined goat population are presented in Table 1.

DGAT2. Molecular analysis showed that the described SNP in the exon 4 at position C234A in the DGAT2 gene was monomorphic in the Czech dairy goat breeds studied. All the animals typed had the CC genotype. Sequence analysis did not confirm the polymorphism site at C234A that was described in two Chinese goat breeds (An et al., 2011). The frequency of genetic variants was balanced: the C allele frequency ranged from 0.67 to 0.64 and the D allele frequency, from 0.33 to 0.34. In the future, it will be necessary to monitor the occurrence of the DGAT2 genetic variants in other European goat breeds and to determine their effect on economic production properties.

BTN1A1. At the BTN1A1 locus, the minor allele A was observed at a frequency of 13 percent. The frequency of the rare genotype AA was only 3 percent (Table 2). Compared with the study of Qu et al., (2011), the frequency of both alleles (ancestral and minor) M and N was more balanced in two Chinese breeds – 0.549 and 0.600 for the M allele and 0.451 and 0.400 for the N allele – than for the Czech dairy goat breeds and cross-breed. To confirm the described polymorphic site in the exon 4 at position 218T > C, CTT (Leu) > TTT (Phe) (GU569967), sequencing analysis was used and identified two new SNPs in exon 4: 214T > C and 216 A > G, (GU569967). The first of these was monomorphic, while the second changed Gln to Lys in 184AA of mature peptide (NM001285618.1).

SCD. Three genetic variants were typed A, B and C, with five genotypes described as AA, AB, AC, BB and CC at the SCD locus. Analysis showed a prevalence of the B allele (82.24 percent) followed by the A allele (14.47 percent). The C variant was identified at a very low frequency (3.29 percent) in the Czech dairy goat breeds and cross-breed. The most prevalent genotype was BB, followed by AB.

Genotypes AA, AC and CC had very low frequencies of occurrence in the study (Table 2).

In contrast, in the genotype detected in two Chinese goat breeds (Chen et al., 2011), the most dominant allele was A (51 and 57 percent), compared with B (2 and 11 percent) and C (33 and 47 percent). The predominant genotypes were AC and AA (with almost equal distributions). Genotypes BC, AB and CC had low frequencies of occurrence, and genotype BB very low frequency in the monitored Chinese goat breeds. The SNPs describe by An et al. (2011) were confirmed in the Czech dairy goat populations.

Based on molecular analyses at the DGAT2, BTN1A1 and SCD loci, it can be concluded that differences in gene variability are probably due to breed. It will be necessary to carry out further analyses to describe how these breeds differ from each other.

According to the Hardy-Weinberg rule, the goat population was in genetic equilibrium only at locus BTN1A1 ($P \leq 0.001$); goat populations at loci DGAT2 and SCD were not in genetic equilibrium. Observed and expected heterozygosity and PIC were also calculated; the PIC showed a small value for both BTN1A1 and SCD loci, indicating high genetic homogeneity in the Czech goat breeds and cross-breed studied. It can be concluded that without supporting phenotypic data, the Hardy-Weinberg equilibrium and the PIC give only basic information about genetic diversity in the selected loci.

Conclusion

The results obtained from typing allele frequencies and genotype distribution of the DGAT2, BTN1A1 and SCD gene in two Czech goat breeds and a cross-breed confirmed that the genetic polymorphism described in two Chinese goat breeds also exists in the Czech goat populations. However, the characterized SNP at the DGAT2 locus was not confirmed in the Czech goats. The study confirmed the described polymorphic site at the SCD locus and identified two new SNPs at the BTN1A1 locus. The investigated alleles and genotypes identified at selected loci are assumed to be ancestral and typical of the Czech dairy goat breeds and cross-breed. These primary results indicate the need for continued research to confirm the characterized SNP, identify new SNPs at selected loci, and discover their association with production traits to improve performance.

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TABLE 2. ALLELE FREQUENCIES, GENOTYPE DISTRIBUTIONS, GENE DIVERSITY AND HETEROZYGOSITY, PIC AND HARDY-WEINBERG EQUILIBRIUM AT BTN1A1 AND SCD LOCI IN CZECH DAIRY GOAT BREEDS

Marker	Geno-type	Count	Freq.	Allele	Count	Freq.	He	$He_{(obs)}$	PIC	Chi square value
BTN1A1	AA	6	0.03	A	61	0.13				
	AG	49	0.21	G	399	0.87				
	GG	175	0.76				0.23	0.21	0.20	1.25
Total		230	1.00		460	1.00				
SCD	AA	3	0.02	A	44	0.15				
	AB	32	0.21	B	250	0.82				
	AC	6	0.04	C	10	0.03				
	BB	109	0.72							
	CC	2	0.01							
Total		152	1.00		304	1.00	0.30	0.25	0.27	43.89

He = gene diversity expected.
*$He_{(obs)}$ = gene diversity observed.

GENETIC BACKGROUND OF MILK PROTEIN ALLERGY

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Abstract

The main aim of this paper was to summarize the latest knowledge in the field of genetic polymorphism in the main caprine milk protein genes: α-lactalbumin, β-lactoglobulin and αs1-, αs2, β- and κ-caseins.

In almost all European countries, the primary uses of goats are for milk and cheese production. During cheese production, the amount and quality of the product are determined primarily by caseins (especially the αs1-casein) from the six major milk protein fractions. Several studies on the polymorphism of milk protein genes and milk traits have been carried out. This study refers to these results and gives a brief review of current knowledge on the gene structure of the main caprine milk proteins. This information is followed by a comparison with the polymorphism of bovine and ovine milk protein genes and their special characteristics in relation to milk protein allergy. In Europe and worldwide, the consumption of cow milk is dominant, but interest in the milk of other species is increasing. Milk has a very important role in the human diet, but more and more people are avoiding its consumption because of the spread of milk allergy.

Key words: polymorphism, goat, review, allergy

Milk allergy

Based on average data, food allergies affect up to 8 percent of children and 2 percent of adults. Milk allergy is responsible for a significant ratio of food allergies. About 3 percent of infants are born sensitive to milk proteins, but this phenomenon declines to about 1 percent in adults. For example, this means that the everyday lives and healthy nutrition of about 300 000 people living in Hungary are affected by this problem, while the effects on their families mean that milk allergy presents difficulties for 1 million people. This disease cannot be cured, but can be controlled by keeping to a strict diet, which involves significant expenditure for those affected.

According to the latest knowledge, people suffering from cow milk allergy can also develop an allergy to the milk of small ruminants through cross-reactions. This allergy can be treated only when certain conditions are met.

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For healthy nutrition, especially in the first decade of life, the nutrients of milk are essential. To ensure that people who are sensitive (allergic) to certain milk protein fractions receive the nutrients of milk, there is need to develop a method of eliminating the triggering material of the allergy from the milk without involving artificial interactions.

Luckily, the milk protein fractions that cause allergic reactions (αs1 casein, αs2 casein, β casein and β lactoglobulin) have numerous variants, not all of which trigger allergic reaction. The different variants can be separated through deoxyribonucleic acid (DNA) tests. This makes it possible to produce, through natural means (without artificial interaction), milk products that do not contain the fractions causing allergy, by selecting goats and sheep that produce milk with the required composition. This milk can then be processed into products that people who are allergic to milk can consume without any negative consequences.

Milk protein allergy

Numerous articles and news stories without any scientific background have been published in journals and magazines worldwide proclaiming the favourable dietary and health-improving effects of goat milk, but very few scientific studies have been published on this topic. Beck (1989) describes 54 Australian cases of the favourable effects of goat milk, but no other similar summary has been published although several international scientific journals have included papers on this theme.

Exploitation of the dietary and physiological advantages of goat milk is closely related to human nutrition and health problems. Allergy to cow milk changes with age and location and there are no exact data on its frequency because it is difficult to compare the results of different diagnostic and analytical methods (Kaiser, 1990).

In Europe and worldwide, the consumption of cow milk is dominant, but interest in the milk of other species is increasing. Milk has a very important role in the human diet, but more and more people are avoiding its consumption because of the increase of milk allergy. Allergy is caused mainly by the proteins in milk; for some people, lactose causes digestion problems (lactose intolerance), but this is not an allergy. The allergenic effect of αs1-casein, α-lactalbumin and β-lactoglobulin in cow milk has been known for years (Sieber, 2000).

Goat milk, sheep milk and their products are not recommended for people who are allergic to cow milk because of the strong cross-reaction among the milk of different animals (Polgár et al. 1996). However, researchers have not reached consensus as to whether cow milk can be replaced by the milk of other animal species. Some researchers suggest giving goat and sheep milk to children only after the age of two years, while others recommend its consumption from infancy onwards. To replace cow milk, other alternatives considered include soy milk and casein and whey products. According to British research results, goat milk is suitable for treating allergy and other cases such as malabsorption syndrome, especially during childhood (McCullough, 2003). However, in France it was found that neither goat nor sheep milk were suitable replacements for cow milk for allergic patients, as a life-threatening anaphylactic shock can occur in some cases. For children suffering from allergy, these authors do not suggest the consumption of goat or sheep milk, while certain patients tolerate donkey, camel and horse milk better.

The greatest problem regarding milk allergy is that the food industry is using increasing amounts of goat and sheep milk in their products, which can be dangerous for people who are allergic to milk (Moneret-Vautrin, 2004). Compared with cow milk, goat milk contains less αs1-casein, but more αs2- and β-casein, while ewe milk contains more of all three proteins than cow milk (Spuergin et al., 1997). Bernard et al. (1999) found 87 and 97.4 percent similarity in the amino acid composition of cow and ewe milk and goat and sheep milk, respectively.

About 2.5 percent of children under the age of three suffer from cow milk allergy worldwide, but this value is 7–8 percent in Scandinavia (Høst, Husby and Osterballe, 1988), while Nestle (1987) reports ratios of more than 20 percent in some areas. According to Haenlein (2004), replacement with goat milk can solve 30–40 percent of these cases. However, in 85 percent of cases of cow milk allergy in one study, polysensitivity was detected for caseins and lactoserum proteins such as α-lactalbumin and β-lactoglobulin (Bernard et al., 1999).

The complexity of cow milk allergy is caused by the genetic polymorphism of caseins and whey proteins, which makes it hard to identify which protein fraction is responsible for the allergic reaction (Grosclaude, 1994). Of the 18 protein fractions in cow milk, β-lactoglobulin cannot be found in human milk, so it is assumed to be the most harmful regarding allergy, although comparative examinations by Bürgin-Wolff et al. (1980) and Taylor, Thiessen and Murray (1986) did not find a significant difference in the allergenic effect of β-lactoglobulin and casein of cow milk. According to the results of Kaiser (1990), in skin-prick tests, α-lactalbumin caused the most positive skin reactions on 21 adult and 13 infant patients with cow milk allergy.

According to Marletta et al. (2005), the allergic effects of three casein fractions (homozygous normal, homozygous 0 and heterozygous normal) were similar. Based on the number of samples, three levels (C20, C50 and C80) were created, according to the percentage of α s2-casein and the seroprotein content of the sample. In the case of C50, the most allergenic was homozygous normal followed by homozygous 0 and heterozygous normal. Based on these results, protein fractions have a much greater role in allergic reactions than seroproteins, and a lack or low level of α s2-casein reduces the allergic effect only slightly.

Cross-reactions between the caseins of cow and goat milk are well known, but Paty et al. (2003) report that numerous cross-reactions can also occur between goat and sheep milk. When a goat milk-specific IgE is present, the radioallergosorbent test (RAST) shows a positive result for sheep milk. The main allergens were found to be αs1- and β-casein in both goat and sheep milk. On the other hand, the slight differences in the amino acid sequences of caseins may explain why allergic reactions can occur during the consumption of goat and sheep milk in people who are not allergic to cow milk. Based on their results, Paty et al. concluded that milk types can be differentiated according to the protein fractions determined by the different alleles, making it possible to avoid the causes of allergy in a natural way.

In Hungary, a few studies have been carried out on goat milk allergy, but none on sheep milk.

Problem of milk composition

Milk and dairy products have always been important in human nutrition, and were one of the earliest areas of research into animal breeding and genetics. The amount of milk produced was significantly increased through traditional breeding methods, but increases were frequently accompanied by deterioration of the milk content parameters. To select the individuals that produce milk of a favourable composition, molecular genetic methods are of great assistance. The milk protein genes of important milk producing domestic animal species have been isolated and the genetic variants influencing milk quality described.

In Hungary, the demand for goat and sheep milk and their products is not high, but consumers are willing to pay high prices for them in France and Slovenia. Medical research has proved that goat milk and its products have a very favourable physiological impact. Goat milk is the healthiest milk type: its vitamin content is much higher than that of cow milk, and it is easy to digest and tastes good. It, therefore, has an important role in the diet of people with stomach and digestion problems and is excellent for the elderly because of its high protein content. Its favourable calcium–phosphorus ratio mean that regular consumption of goat milk can prevent osteoporosis. It is widely assumed that sheep milk does not cause allergy. However, the basis of this belief has been shaken in recent publications, which report that allergic reactions to sheep (and goat) milk can occur in people who are not allergic to cow milk.

In recent decades, several authors have studied the milk composition of the two small ruminant species. These authors have found that breed variety and feeding practices have impacts on milk composition, but the affects of management technologies on milk composition (e.g. vitamin D and calcium contents) have not yet been studied. Studies of cow milk production show that intensive, extensive (grazing only) and semi-intensive management technologies affect not only the mineral and vitamin content but also the macro- and microcomposition of the milk. These effects are completely unknown for sheep and goat milk. Through in-silico analysis of αs1-, αs2-, β- and κ-caseins and β-lactoglobulin, Dixit, Ak and Singh (2012) found that sheep milk is a more suitable alternative to cow milk for allergic infants, and buffalo milk, for allergic adults.

Another study found no significant difference between goat and sheep αs1 and αs2 proteins; both have the same properties and are useful alternatives for children who are allergic to cow milk (Masoodi and Shafi, 2010).

Composition of goat milk

In almost all European countries, the primary uses of goats are for milk and cheese production. It is primarily caseins (especially αs1-casein) from the six major milk protein fractions that determine the amount and quality of cheese during cheese production

Boulanger et al. (1984) identified seven αs1-casein variants (alleles). Later, it was realized that the genetic variants can be classified according to their amounts in goat milk, and high, medium and low variant groups were identified (Grosclaude et al., 1987). As the αs1-casein content of the milk of goats in variants A, B and C is about 3.6 g/litre, these variants belong in the high group, while variants E (1.6 g/litre), D and F (0.6 g/litre) are classified in the medium and low groups, respectively. According to Grosclaude et al. (1987), all variants play an important role in the synthesis of αs1-casein. In the late 1990s, three further genetic variants of αs1-casein were identified (Martin and Addeo, 1996). Consequently, 55 different allele combinations are possible in goats. The presence of αs1-casein in variant G was found to be low (similar to variants D and F), and three subvariants of B – B1, B2, B3 – were found to be in the high group.

Some authors consider null variants as a fourth group. Clark and Sherbon (2000) described 22 combinations of ten αs1-casein genetic variants – A, B1, B2, B3, C, D, E, F, G, and 0 – in 93 North American goats. The combination F/F was found to be the most frequent (37.6 percent). F/E and E/E represented 10.8 percent, while only 4.3 percent of the goats were 0/0 homozygous for αs1-casein. In all the other homo- and heterozygous combinations, only high variants were found, but these combinations were very infrequent (e.g. A/A accounted for 2.2 percent of the total and C/A for 1.1 percent). According to Clark and Sherbon, F (54.1 and 45.5 percent) and E (20.3 and 31.9 percent) were prevalent in the Alpine and Saanen varieties, while in Nubian goats, F dominated (41.7 percent), E was absent and A was the second most significant variant (25 percent). The frequency of the other variants ranged between 1.4 and 6.8 for Alpine and 4.6 and 9.1 for Saanen, but variants C, D and 0 were missing. The authors compared their results with those of earlier studies and found that the frequency of αs1-casein variants in North American goats (Alpine and Saanen) was similar to those found in France and Italy. The most important difference was in the frequency of variant E, which was 18.8

percent in the North American study, while the Italian and French researchers found it to be 30–40 percent (Clark and Sherbon, 2000).

Numerous researchers have mapped the relationships between casein types and milk composition. Goat milk with high αs1-casein content was found to have better milk composition, including higher fat, protein, casein and phosphorus contents and lower pH (Clark and Sherbon, 2000). In addition, the coagulation time of goat milk with high αs1-casein content is longer, but the coagulation level is higher and the resulting product is more solid than that of goat milk with low αs1-casein content (Clark and Sherbon, 2000). According to Ryniewicz et al. (1996), the protein, casein and soluble solid contents are higher and the quality of the congealment is better in goat milk with high αs1-casein content. Manfredi et al. (1993), Remeuf (1993) and Barbieri et al. (1995) came to similar conclusions regarding casein, total protein and milk fat contents. In goat milk with A/A type αs1-casein content, nitrogen and fat contents are higher than in the 0/0 type (Pierre et al., 1996). From the A/A type milk, larger quantities of more solid cheese can be produced and the "goaty" odour is less detectable.

Aleandri et al. (1990) suggest that during the selection of goats, genetic combinations for optimal cheese production and higher fat and protein contents should be considered. For profitable production, it is very important to know which αs1-casein genetic variants are responsible for better milk composition and coagulation characteristics. Jordana et al. (1996) studied the αs1-casein content and variants in the milk of four Spanish goat varieties. Another study found that Norwegian dairy goats have extremely high frequencies of an αs1-casein "null" allele (Devold et al., 2010). For the three continental goat varieties (Murciana Granadina, Malaguena and Payoya) variant E was found to be prevalent (60–75 percent). High variants (A, B, C) ranged between 18 and 31 percent, while low types (F, D) and 0 variants accounted for a maximum of 17 percent of the total. F, D and 0 variants could not be detected in the milk of the Payoya variety. Differences were found among the three subtypes of the fourth variety, Canaria, and between it and continental goats. For this variety, high variants were dominant, averaging 60 percent. The same variants (A, B) were found in similarly high ratios in Italian Garganica and Maltese varieties by Ramunno et al. (1991). Variant E in Canaria variety (Jordana et al., 1996) ranged between 9 and 32 percent. Grosclaude et al. (1994) concluded that the frequency of high type variants was low, not only in the Alpine and Saanen varieties with strong selection for milk production, but also in unselected, isolated goat varieties such as Corsican goats. However, contradictory results were found in local varieties such as Canaria or Garganica, where the frequency of high type variants was high.

Based on these results, it seems that selection for milk quantity has a strong effect on the distribution of αs1-casein variants in goat milk. Clark and Sherbon (2000) found the lowest amounts of all milk constituents in the milk of 0/0 animals, while the amounts of fat, protein, fat-free soluble solids and total soluble solids were highest in milk containing high type αs1-casein variants. These authors claimed that the medium type E variant is the best for improving milk composition, but the difference between the milk compositions of E and 0 variants was not significant. There was no significant difference in the coagulation characteristics of milk samples from animals with different variants and combinations, but a strong trend could be observed in which both the coagulation time and the firmness of the congealment were lower in milk with 0/0 αs1-casein genetic variants than in milk from the other types (low, medium and high).

According to these conclusions, goats of the 0 αs1-casein genetic variant should be removed from the stock by selection, while goats inheriting A, B1, B2, B3 and C variants and their combinations should be bred further to improve milk composition and increase cheese production. Another solution would be through selection of the variety, as the milk of Nubian goats contains significantly more high type variants than that of Alpine or Saanen goats (Clark and Sherbon, 2000). In the study of Addeo et al. (1989), goat milk with no αs1-casein content was more sensitive to ethanol and heat, its coagulation time was longer and the resulting congealment was softer. In France, goats with A, B and C alleles produced significantly less milk, but more casein, and the congealment of their milk was more firm than that of goats with B and 0 genotype (Remeuf et al., 1989).

At Hungary's Agricultural Biotechnology Center, in collaboration with the University of Debrecen and the Research Institute for Animal Breeding and Nutrition (Herceghalom), goat milk casein fraction model studies were performed using Hungarian milking goats. The frequency values of αs1-casein obtained for Hungarian milking goats were significantly different from those published in the international literature (Veress et al., 2004; Kusza et al., 2007).

The two variants of αs2-casein A and B were analysed first by Boulanger et al. (1984). As technical developments led to more precise analytical methods, variant C was detected by Bouniol et al. in 1994. Seven αs2-casein alleles were found in goats, and were classified into three groups based on the αs2-casein content of the milk. The αs2-casein content (about 2.5 g/litres) is missing in the 0 allele (Ramunno et al., 2001b), reduced in the D allele (Ramunno et al., 2001a) and normal in all the other known alleles (A, B, C, E and F) (Bouniol et al., 1994; Lagonigro et al., 2003).

According to Ramunno et al. (2001b), the 0 allele has a significant effect on goat milk composition, as the normal variant and the heterozygous normal accounted for only 16 and 9 percent of the total casein, respectively. The presence of allele 0 is relatively high in Hungarian milking goats compared with other European goat populations (Kusza et al., 2007).

According to Moioli, Pilla and Tripaldi (1998), β-casein is one of the most important casein fractions in goat milk, although the first publication to discuss it was not published until 1989. Using the polyacryl-amid gel-electrophoresis method, Ramunno et al. (1995) detected β-casein in local Italian goats and also found the 0 variant in Corsican goats. Examining cow, buffalo, sheep and goat milk, Iranian researchers found the highest amounts of proteins in sheep milk and the lowest in goat milk; the highest amount of β-casein was in goat milk, but this was accompanied by the lowest α-casein content.

The significance of κ-casein is in the formation and stabilization of micelles. In cheese production, the peptide bounds between phenyl-alanine and methionine are broken. Based on existing studies the A + B allele and C allele are differentiated. According to Spanish researchers, allele C has a high frequency in Saanen stock selected for milk production, while its frequency is low or non-existent in other varieties. The frequency of κ-casein alleles in Hungarian goats is very similar to that of French Saanen goats (Veress et al., 2004). According to other Spanish studies, B homozygous goats produce significantly more milk with higher casein content than those of the other two genotypes (Angulo et al., 1994).

Conclusions

Several ongoing projects aim to develop less allergenic food products based on sheep and goat milk containing potent and stable allergens that do not trigger allergic effects, and to improve food safety through strategies that prevent allergen contamination. This approach includes developing sensitive and reliable methods for detecting allergens and carrying out allergenic assessments of foods containing animal milk. DNA-based methods of allergen determination in foods are being developed and applied.

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RECENT PERSPECTIVES ON GOAT PRODUCTION IN TURKEY

Irfan Daskiran[43] and Nazan Koluman[44]

Abstract

Goat breeding has had an important socio-economic role in Anatolian culture for many years in Turkey. Turkey has approximately 10.3 million goats, attractive breeding systems and genetic diversity, and is one of the major goat breeding countries in Europe. The well-known Turkish goat breeds are Angora (Mohair), Kilis, Damascus, Hair and Honamli. The goat population of Turkey is composed mainly of the Hair goat (97 percent) (Anatolian Black), with various local types making up the remaining 3 percent. The Hair goat serves multiple purposes (mainly meat and milk), but its productivity is quite low. Goat production is distributed across Turkey, especially in mountainous regions of the Mediterranean, southeast Anatolia and southwest Anatolia. Production systems are mainly extensive and semi-extensive, but investment from the private sector has been increasing in recent decades.

To increase the income from goat production and improve the socio-economic status of goat breeders, the Ministry of Food, Agriculture and Livestock (MFAL) has started a National Sheep and Goat Breeding Programme involving breeders and breeders' associations (the Turkish Sheep and Goat Breeders' Association). The project started with 2 breeds (Akkaraman sheep and Angora goats), and reached 12 sheep and goat breeds, 472 breeders and 800 000 animals in its first stage. In the second stage, the project was expanded in response to its success and requests from breeders. At present, it covers 7 goat and 23 sheep breeds with a total animal population of approximately 800 000 heads. The project involves several partners (breeders' associations, universities, and the research institutes of MFAL) and aims to improve native pure-bred species together with sheep and goat yields while establishing a national breeding programs for goat and sheep production in Turkey. This paper shares field experiences from the project and best practices for goat production and goat products in Turkey (Daskiran and Ayhan, 2013).

Key words: goat production, Turkey, goat breeds, breeding program

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Introduction

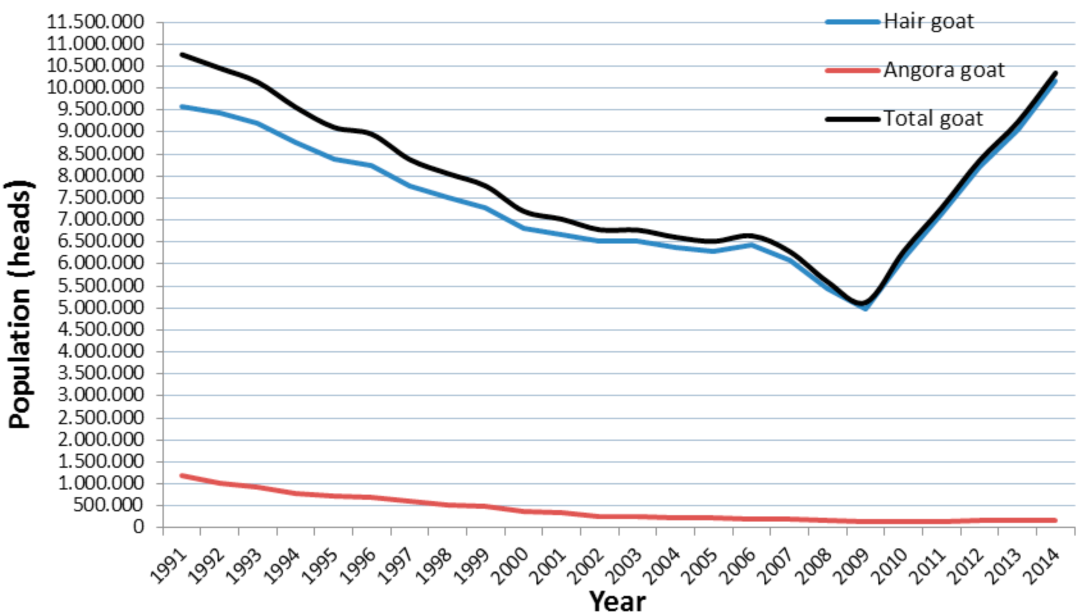
The total land area of Turkey is 785 347 km2 and the population was 75 627 384 in 2012 (TURKSTAT, 2014). Turkey has geographical advantages and varied domestic animal genetic resources. It plays a very important role in livestock production in Europe and is also one of the world's most important countries in terms of livestock population. Turkey has 31.1 million sheep and 10.3 million goats (Figure 1), representing 28 percent of the European sheep population and 63 percent of its goat population (FAOSTAT, 2013; TURKSTAT, 2014). Although sheep and goat production has many advantages in Turkey, the milk yields per head and the growth and carcass yields of animals are very low and insufficient for intensive production.

Turkey has attractive breeding systems and genetic diversity for goat farming, and is one of the major goat breeding countries in Europe. The well-known Turkish goat breeds are Angora (Mohair), Kilis, Damascus, Hair and Honamli. Most of the goat population is composed of the Hair goat (97 percent) (Anatolian Black), which serves multiple purposes (mainly meat and milk), but has low productivity. Goat production is distributed across Turkey, especially in the mountainous regions of the Mediterranean, southeast Anatolia and southwest Anatolia. Production systems are mainly extensive and semi-extensive.

The goat sector in Turkey

The goat sector of Turkey includes diverse systems. The coastal Mediterranean region has similar systems to those of other Mediterranean countries. Goat farming is preferred by poor livestock farmers, but has been disadvantaged compared with other livestock sectors. Turkey's goat population was very high in the 1960s, but then decreased rapidly. Trends in the goat population of Turkey are shown in Figure 1.

FIGURE 1. TRENDS IN THE ANGORA AND HAIR GOAT POPULATIONS OF TURKEY



This rapid decrease resulted from many factors, including migration to urban areas from rural regions, young rural people's lack of interest in livestock production, the low incomes generated from goat production, and the reduced importance of goat and natural animal fibers in the modern textile sector following the introduction of synthetic fibers. Turkish Angora goat breeders have not adapted to changes in marketing conditions and the modern breeding sector and had stopped breeding Angora goats, but this trend started to reverse about five years ago. The goat sector in Turkey can be divided into five categories: extensive, semi-intensive, intensive, nomadic, and mixed sheep and goat systems.

Extensive systems

Extensive goat systems are very common in Turkey, with herds ranging from 50 to 500 heads. Goat breeders have low economic status and do not use supplementary mixed feed in harsh winter and environmental conditions. The feeding system is generally based on spring and summer grazing. There is insufficient application of animal health protection and preventive medicine. Housing systems are very poor, and goat sheds in extensive systems are based on traditional models with insufficient ventilation and lighting. The main income of goat breeders in the extensive system comes from the sale of kids, meat and goat cheese. In the past, goat farmers produced handmade blankets and clothing. Farmers with herds of more than 300 heads can hire shepherds, but, generally, they use household members to manage their goat herds.

Semi-intensive systems

Semi-intensive systems are more developed and implement better management than extensive systems. Semi-intensive goat breeders and farmers use some modern feeds, housing and management systems. They use good-quality bucks for breeding and supplementary concentrate feeds in winter; basic selection methods are applied on their farms. These farmers process their goat milk in small-scale cheese units, and attend to animal diseases and health issues. They have permanent shepherds to manage their goat herds. Some semi-intensive farms use controlled mating methods and limited animal registration systems. Semi-intensive goat farms are concentrated in the west of Turkey, but there are also some in southeast Anatolia and the east Mediterranean region.

Intensive systems

These goat farms generally use modern breeding and housing systems and animal health and veterinary services. They also have full animal registration systems and use software programs. Their housing is modern and well ventilated, with fully or semi-mechanized feeding systems. They have modern facilities for processing goat milk and producing cheese, with automated milking systems. Intensive goat farms use the services of professional veterinarian and animal breeding experts (zootechnicians). Their herds often exceed 1 000 heads. Intensive goat farmers take animal welfare into account and design their barns according to animals' ages and sexes and other technical issues. Their feeding system is fully controlled and they do not use free grazing for their goats, but reserve areas of pasture for goat bedding, etc. They use modern selection and mating systems and try to improve their animals' yield characteristics for milk or meat.

Over the last decade, investments from the private sector have increased, especially in western Turkey. Consumers' high demand for goat products is motivating the private sector to invest in modern goat farms and goat milk products.

Nomadic and transhumance systems

Nomadic and transhumance systems are very popular in the Mediterranean and east Anatolian regions of Turkey. However, the increasing adoption of modern production systems has resulted in declines in the nomadic system, while transhumance is also being replaced by sedentary systems. These two systems are very traditional, with each family member having an active role in goat and sheep management. Animal health and feeding systems are very primitive, and the economic and social situations of these farmers are very poor. They process milk into cheeses under unhygienic conditions using traditional methods and selling the cheese directly at local markets or to local traders. Traditional cultural heritage is important in both systems, and farmers try to maintain ancient immigration routes and cultural values. The Karakeçili, Sarikeçili, Akkoyunlu and Dulkadir nomadic tribes are highly regarded in Turkey.

Mixed sheep and goat systems

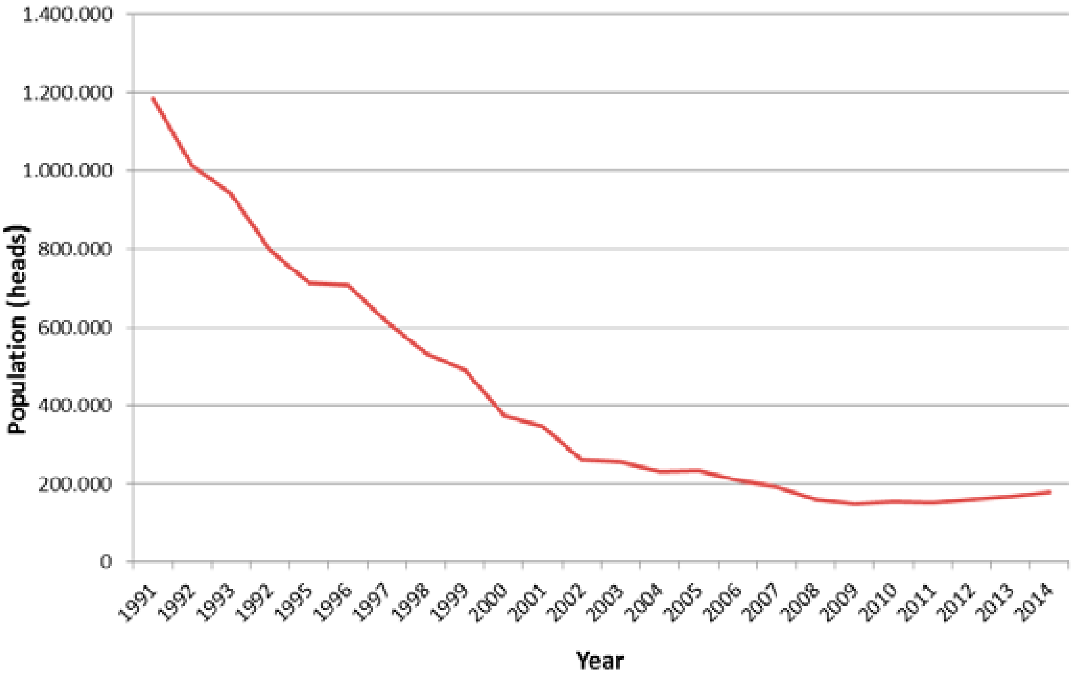
Turkey has approximately 3 million livestock farms, of which 95 percent are sheep and goat farms. Mixed farms are concentrated in central, east and southeast Anatolia. Extensive sheep farmers find it easy to control and manage goats while their sheep graze, and keep goats to provide their family with money, meat and milk products.

Angora goat production in Turkey

Angora goats are a native breed that is perfectly adapted to the steppe conditions of central Anatolia (Orkiz, 1980). They are raised mainly for mohair production, to provide raw material for the textile industry. Angora goats are an important source not only of cash income for farmers through sales of their mohair and meat (or of the animals themselves), but also of meat and milk, providing high-quality protein for rural people (Hunter, 1987). The name "Angora" originated from the ancient name of Ankara, which is located in central Anatolia and has been the capital of Turkey since 1930 (Yalçin, 1986). Angora goat farms are located mainly in the lowland areas of central Anatolia, but a few are in southeastern provinces. South Africa, Turkey and the United States of America are among the world's leading countries for Angora goat breeding (Gunes et al., 2002; Van der Westhuysen, 2005).

Angora goat farms are relatively insensitive to external factors such as the globalization of state economies and regional marketing conditions. Comparing Turkish Angora goats with North American and South African goats provides valuable information for improving the mohair production of Turkish goats (Morand-Fehr and Boyazoglu, 1999). Data from TURKSTAT (2014) indicate that over the last 20 years the number of Angora goats in Turkey has decreased by almost 89 percent (Figure 2).

FIGURE 2. TREND IN THE ANGORA GOAT POPULATION OF TURKEY



This decreasing trend is related mainly to socio-economic and political factors, such as migration from rural areas, reduced income from mohair production compared with milk and meat production, insufficient support for Angora goat breeders and restrictions on goat rearing close to woodland areas.

Goat products

Although the demand for any product depends on the income of its consumers, the demand of Turkish consumers for goat products is similar to that of consumers in other developed countries. Modern intensive goat farms produce high-quality goat milk products such as cheeses, ice creams and yoghurt, while small-scale goat farms also produce milk processed into local products. Important local goat products include:

- milk;
- labne (mild cream cheese);
- local cheeses;
- tulum cheese (a very sharp and salty cheese wrapped in goatskin);
- Hellim cheese;
- Maraş ice cream;
- Siirt blankets (produced from the mohair of Angora goats);
- carpets;
- mohair traditional socks;
- soap;
- Büryan goat meat kebab.





Photo 1: Maraş ice cream; Photo 2: Siirt blanket (produced from the mohair of Angora goats); Photo3: Büryan goat meat kebab; Photo 4: Büryan goat meat kebab; Photos 5 and 6: Goat cheeses; Photo 7: Tulum cheese (source: Anonymous, 2013)

Challenges in the goat sector

Although Turkey has a large goat population and 3 million goat farms, the main problems in the goat sector are the small size of the herds and the dependence on family members to manage the farms. Native (indigenous) breeds are the main components of goat farms. Indigenous breeds are very well adapted and have desirable characteristics such as resistance to diseases and parasites, good herding instincts, the ability to walk long distances in search of feed, high tolerance to adverse climate conditions, and endurance to droughts and fluctuating nutrient availability. However, the low genetic capacity of indigenous breeds is a major handicap for effective goat production.

The total cost of inputs (concentrate feed, animal health expenses, shepherds' wages, etc.) for goat production is very high, which effects the production of economical goat products (fleeces, milk, etc.). Animal health and veterinary services are inadequately organized in some regions, while private veterinary services are very expensive. Other major problems for goat farmers include overgrazing on pastures and grazing in forest areas. In addition:

- most of the population is indigenous breeds;
- local breeds have low genetic capacities;
- small farms do not use modern technologies;
- small-scale family farms are not effective;
- there is no cooperation among producers;
- animal production is no longer attractive to young people;
- there is no feed for winter conditions;
- goat products face marketing and processing challenges;
- goat breeders lack technical knowledge;
- breed associations face animal registration problems,
- breeders' associations face infrastructure problems.

Recommendations

Goat production in Turkey has developed in recent years. The private sector prefers to use modern goat-raising systems and is making the necessary investments. The Ministry of Agriculture, Food and Livestock provides financial support to goat breeders through breeding projects that help to improve the extensive goat production systems:

- Goat production systems should be improved and coordinated by the Sheep and Goat Breeders' Association.
- Animal registration and data management systems for goat breeding should be developed.
- Diverse goat products should be produced and their markets should be supported.
- Goat farmers should be educated about animal health and breeding strategies.
- Goat production based on low-yield indigenous animals results in very low milk, meat and other yields. Male and female goats of high genetic capacity should be provided to farmers.
- Goat farmers should be supported in adopting modern enterprise systems.
- Shepherds' salaries are high and it is difficult to find qualified shepherds. In addition, the working conditions for shepherds are very difficult and they do not have

health insurance. Legal rights have to be provided for shepherds.

- Legal grazing in forest areas should be reorganized and a grazing plan drawn up by the Ministry of Forestry.

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GENETIC IMPROVEMENT OF HONAMLI GOATS UNDER BREEDER CONDITIONS IN ANTALYA, TURKEY

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Summary

Honamlı goats are breed by nomadic farmers in Antalya, Burdur, Isparta and Konya regions, in the Taurus Mountains of the Mediterranean region of Turkey. The bodies of Honamli goats are mainly black and pure breeds animals from the Antalya region have white or brown foreheads and legs and black bodies. Grey spotting sometimes occurs. The most important morphological characteristic of the Honamlı Goat is its arched nose. Characteristics such as nose, neck, body and tail length and distance from the ground are different from those of other breeds (GDARP, 2011). Previous studies, found average birth weights of 4.1 kg for male and 3.7 kg for female kids (Elmaz, et al., 2012a). Average weaning weights were 26.9 and 23.4 kg respectively. Percentages of multiple births and litter size were 32.8 and 1.35 percent, respectively (Elmaz, et al., 2012a). Average live weights of Honamlı does and bucks were 63.5 kg and 77.3 kg, respectively, with averages of 83.0 cm for withers height, 83.3 cm for rump height, 83.3 cm for body length, 91.0 cm for chest circumference, 20.8 cm for tail length and 9 cm for nose length in does. Equivalent values for bucks were 91.2 cm, 90.1 cm, 93.0 cm, 94.7 cm, 24.0 cm and 26.4 cm, respectively (Elmaz, et al., 2012b).

The General Directorate of Agricultural Research and Policy (GDARP) of Turkey's Ministry of Food, Agriculture and Livestock is supporting a new study on genetic improvement of Honamlı Goats under breeder condition in Antalya, which is running for five years (2011–2016). The study will examine the growth traits and survival rates (until weaning) of Honamli goats before estimating the value of Honamlı goat breeding.

 

Photo 1: Honamlı buck, white arched nose (Source: Özkan Elmaz, 2014); Photo 2: Honamlı doe (Source: Özkan Elmaz, 2013)

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MILK YIELD AND COMPOSITION TRAITS OF HAIR GOATS UNDER EXTENSIVE CONDITIONS IN THE CENTRAL ANATOLIAN REGION OF TURKEY

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Abstract

This study was carried out in Selçuklu district of Konya province in the Central Anatolian region of Turkey on three Hair (Kıl) goat herds. The aim was to determine the milk yields and composition traits of Hair goats under extensive conditions. Data were collected during the lactation period from 171 goats aged between two and seven years.

From a month after kidding, the goats were machine-milked monthly and the milk production was recorded. The milk yield traits of the Hair goats were calculated by using the Fleischmann method for investigating milking. Statistical analysis was made using the JMP 11 computer program.

Average lactation length, lactation milk yield and daily milk yield of Hair goats were 205.2 days, 93.3 kg and 0.451 kg, respectively. These parameters varied considerably, from 151.0 to 250.0 days for lactation length, 42.5 to 225.7 kg for lactation milk yield and 0.240 to 0.949 kg for daily milk yield. Average contents of the milk were 5.43 percent fat, 3.77 percent protein, 5.55 percent lactose, 10.16 percent non-fat solids and 15.60 percent total solids.

Age and farm had significant effects on lactation length, lactation milk yield and daily average milk yield ($P < 0.01$) and on fat, protein, lactose, non-fat solid and total solid contents ($P < 0.001$).

The results of the study imply that the high variation in milk yields among Hair goats could be the result of genetic variation. Therefore, the milk yield characteristics of Hair goats might be increased by selection or cross-breeding.

Key words: Hair Goat, Lactation Period, Daily Average Milk Yield, Milk Composition

Introduction

Goat production is economically and socially important in Turkey. An estimated 500 000 farm households keep goats, and goat production contributes directly to the income of nearly 3 million people (Dellal and Dellal, 2005). Goat production provides an important livelihood and food source for families with low incomes living in or on the edges of forest regions.

The word Kıl means hair in Turkish. The indigenous Hair goat is the most common goat breed in Turkey. Of the total goat population estimated at 10.4 million, approximately 10.2 million are Hair goats (TURKSTAT, 2014). Hair goats are frequently referred to as kara keçi, meaning black goat or adi keçi, meaning common goat. These animals are located mainly in the mountainous regions of western Turkey and the Taurus and Anti-Taurus Mountains of southern Turkey (in the Mediterranean and Aegean regions), but they are distributed throughout the country (Ertugrul, 1997; Güler, 2005; Yalçın, 1990).

Hair goats are well adapted to all the climate and rangeland conditions of Turkey. They have strong bodies and are resistant to infectious diseases and cold or hot weather, and they can be raised under difficult living and feeding conditions. They are able to utilize heath and scrubland, and climb well on rugged hilly land. They can be kept on pastures all year round. Generally, they can be raised on scrub, stubble and plants such as shrubs, at high altitudes, in forests or in the villages near forests, at almost no cost. The Hair goats are generally kept as a dual-purpose breed for meat and milk production. Average milk yields range from 90 to 100 kg, and can reach 165–195 kg on good pastures and under good maintenance conditions; the lactation period may be seven to eight months. The breed generally has a medium-sized body, but wide differences in body size are seen across regions. The breed is called the black goat because of its hair colour, but grey, brown or blue-pied goats are also found (GDARP, 2011; Erduran et al., 2015; Erduran and Dağ, 2014; Atay et al., 2013; Sönmez, 1975; Şengonca, 1974; Tuncel and Yener, 1983; Yarkin, 1965).

Producing 415 743 tonnes per annum, Turkey, ranks third in goat milk production among Mediterranean countries after France, and Spain (FAOSTAT, 2013). Goat milk accounts for 2.48 percent of the total milk production of Turkey (TURKSTAT, 2014). Most of this goat milk is processed into local dairy products and consumed regionally, generally by the farming household or in the neighbourhood, or mixed with sheep milk for the processing industry.

The aim of this study was to determine the milk yields of Hair goats kept under extensive conditions.

Materials and methods

For the study, data on 171 Hair goats aged between two and seven years were collected during the lactation period from three private farms in Selçuklu district of Konya province in the Central Anatolia Region. The goats were fed only on natural pasture, including scrubland, with no extra feed. Does and bucks were left together all year round. The birth of kids started at the end of February and lasted through March. Kids were weaned at approximately three months of age. The herd was pastured on rangelands and in forests from early in the morning until noon, when the animals were left to rest in the shade before returning to graze after the heat of the sun had subsided.

A month after kidding, does were machine-milked once a month and their production was measured until it dropped to below 100 g/day. The lactation period was defined as the time from kidding to drying. Lactation milk yields, daily milk yields and lactation periods were calculated by using the Fleischmann method for investigating milking (ICAR, 2009). Samples of milk were taken from each goat and analysed immediately by being passed through an ultrasonic milk analyser twice.

All data obtained were analysed using a General Linear Model procedure. Statistical analysis was performed with the JMP 11 computer program.

Results and discussion

The values found were lactation milk yield of 93.3 kg/doe, daily average milk yield of 0.451 kg/doe, and lactation length of 205.2 days (Table 1).

The effects of age and farm on these parameters in Hair goats were significant ($P < 0.01$). Lactation and daily milk yields increased with age up to four years and decreased thereafter.

Lactation milk yields, daily average milk yields and lactation lengths ranged from 43.2 to 225.7 kg, from 0.240 to 0.949 kg and from 151 to 250 days, respectively in goats aged up to four years (Table 2).

The mean lactation milk yield of Hair goats in this study was 93.3 kg. When this yield was compared with other yields reported in the literature, it was found to be lower than those of Erduran and Dağ (2014) (102.3 kg) Atay et al. (2013) (164.3 kg) and Şimşek and Bayraktar (2006) (146.2 kg); higher than those of Erduran and Yaman (2013a) (78.0 kg for first lactation), Sengonca, Taskin and Kosum (2003) (80.5 kg) and Ata (2007) (64.0 kg), and similar to those of Erduran and Yaman (2013b) (94.5 litres) and Eser (1998) (93.8 kg).

Mean lactation length of Hair goats in this study was 205.3 days, which is shorter than those found by Erduran and Yaman (2013a and 2013b) (227.4 and 225.3 days, respectively) and Atay et al. (2013) 229.6 days), but longer than those of Eser (1998) (167.0 days) and Ata (2007) (132.1 days).

The study found an average daily milk yield of 0.451 kg, which is less than those of Erduran and Dağ (2014) (0.498 kg) and Atay et al. (2013) (0.873 kg), higher than that of Erduran and Yaman (2013a) (0.341 kg), and similar to those of Erduran and Yaman (2013b) (0.419 litre) and Ata (2007) (0.450 litre).

Milk composition values showed differences among ages and farms. The expected mean values of milk composition in the lactation period were 5.43 percent fat, 3.77 percent protein, 5.55 percent lactose, 10.16 percent non-fat solids (NFS) and 15.60 percent total solids (TS) (Table 3).

The effects of age and farm on fat, protein, lactose, NFS and TS content were significant ($P < 0.001$) in this study. The composition of Hair goats' milk varied significantly during lactation, with high values at ages two (protein, lactose) and seven (fat, NFS and TS) and low values at ages two (fat), four (protein, NFS and TS) and five (lactose).

Mean fat content was 5.43 percent in this study, which is higher than those of Ata (2007) (3.98 percent), Eser (1998) (4.57 percent), Erduran (2014) (4.76 percent) and Keskin et al. (2004) (4.3 percent), and similar to that of Gursoy (2005) (5.5 percent).

Mean protein content was 3.77 percent in this study, which is lower than that found by Gursoy (2005) (4.2 percent), higher than that of Keskin et al. (2004) (3.5 percent), and similar to those of Erduran (2014) and Eser (1998) (3.76 and 3.71 percent, respectively).

The highest total solid content was found at seven years of age. This may be because of the decrease in milk volume. The highest NFS, protein and lactose contents, and the lowest fat values were obtained at age two. This may be because of variations in rumen fermentation products.

As shown in Figure 1, Hair goats showed a lactation curve with a steady decrease in average daily milk yields after the peak. All milk content values decreased until the third month of lactation and then increased.

TABLE 1. LEAST SQUARES AND STANDARD ERRORS OF MILK PRODUCTION TRAITS OF HAIR GOATS IN CENTRAL ANATOLIA, TURKEY

		Lactation milk yield (kg)	**Daily average milk yield (kg)**	**Lactation length (days)**
	n	Mean S	Mean S	Mean S
Overall mean	171	93.3 ± 2.66	0.451 ± 0.01	205.2 ± 1.76
Age (years)				
2	21	74.5 ± 6.91 b	0.363 ± 0.03 b	202.3 ± 4.58 ab
3	28	99.0 ± 6.12 ab	0.469 ± 0.03 ab	209.2 ± 4.05 ab
4	33	104.8 ± 5.48 a	0.497 ± 0.02 a	210.4 ± 3.63 a
5	38	99.0 ± 5.18 ab	0.495 ± 0.02 a	197.1 ± 3.43 b
6	31	98.8 ± 5.89 ab	0.461 ± 0.03 ab	213.7 ± 3.90 ab
7	20	83.5 ± 7.43 ab	0.423 ± 0.03 ab	198.8 ± 4.92 ab
	P	0.008	0.006	0.008
Farm				
1	71	110.8 ± 3.79 a	0.537 ± 0.02 a	205.5 ± 2.51 a
2	68	74.6 ± 3.68 b	0.381 ± 0.02 b	195.0 ± 2.63 b
3	32	94.4 ± 5.87 a	0.435 ± 0.02 b	215.2 ± 3.89 a
	P	0.000	0.000	0.000

ab Different superscripts in a column reflect significant differences (P < 0.01). Mean S = standard errors.

TABLE 2. MINIMUM AND MAXIMUM VALUES OF MILK PRODUCTION TRAITS OF HAIR GOATS IN CENTRAL ANATOLIA, TURKEY

		Lactation milk yield (kg)		Daily average milk yield (kg)		Lactation length (days)	
	n	Min	Max	Min	Max	Min	Max
Overall mean	171	42.5	225.7	0.240	0.969	151	250
Age							
2	21	42.5	123.2	0.248	0.560	171	222
3	28	42.8	181.3	0.240	0.837	173	250
4	33	51.4	217.6	0.278	0.949	161	247
5	38	43.2	225.7	0.257	0.937	151	241
6	31	45.8	199.8	0.262	0.869	173	243
7	20	55.4	168.9	0.263	0.798	151	241
Farm							
1	71	52.8	206.4	0.286	0.949	151	250
2	68	42.5	191.4	0.240	0.936	168	216
3	32	55.4	225.7	0.263	0.937	151	241

TABLE 3. LEAST SQUARES AND STANDARD ERRORS OF MILK COMPOSITION TRAITS OF HAIR GOATS IN CENTRAL ANATOLIA, TURKEY

		Fat	NFS	TS	Protein	Lactose
	n	Mean S	Mean S	Mean S	Mean S	Mean S
Overall mean	165	5.43 ± 0.05	10.16 ± 0.03	15.60 ± 0.05	3.77 ± 0.013	5.55 ± 0.02
Age						
2	21	5.13 ± 0.13 b	10.43 ± 0.07 a	15.56 ± 0.13abc	3.89 ± 0.03 a	5.92 ± 0.05 a
3	27	5.37 ± 0.12 ab	10.23 ± 0.06abc	15.60 ± 0.12ab	3.77 ± 0.03 b	5.57 ± 0.04 bc
4	31	5.15 ± 0.11 b	9.92 ± 0.06 d	15.08 ± 0.11 c	3.74 ± 0.03 b	5.45 ± 0.04 cd
5	37	5.53 ± 0.10 ab	10.03 ± 0.05 cd	15.56 ± 0.10 b	3.75 ± 0.02 b	5.39 ± 0.04 d
6	30	5.66 ± 0.11 a	10.08 ± 0.06bcd	15.73 ± 0.11 ab	3.70 ± 0.03 b	5.54 ± 0.04 cd
7	19	5.75 ± 0.15 a	10.31 ± 0.07 ab	16.07 ± 0.15 a	3.77 ± 0.04 ab	5.73 ± 0.05 ab
	P	0.001	0.000	0.000	0.001	0.000
Farm						
1	68	5.20 ± 0.07 b	10.01 ± 0.04 a	15.21 ± 0.07 b	3.76 ± 0.02 b	5.42 ± 0.03 c
2	68	5.11 ± 0.08 b	10.31 ± 0.04 a	15.41 ± 0.08 b	3.83 ± 0.02 a	5.29 ± 0.03 b
3	29	5.98 ± 0.12 a	10.20 ± 0.06 b	16.18 ± 0.12 a	3.76 ± 0.03 ab	5.79 ± 0.04 a
	P	0.000	0.000	0.000	0.000	0.000

ab Different superscripts in a column reflect significant differences (P < 0.01). Mean S = standard errors.

FIGURE 1. CHANGES IN MILK YIELD AND MILK COMPOSITION OBTAINED FROM HAIR GOATS DURING LACTATION IN CENTRALANATOLIA,TURKEY

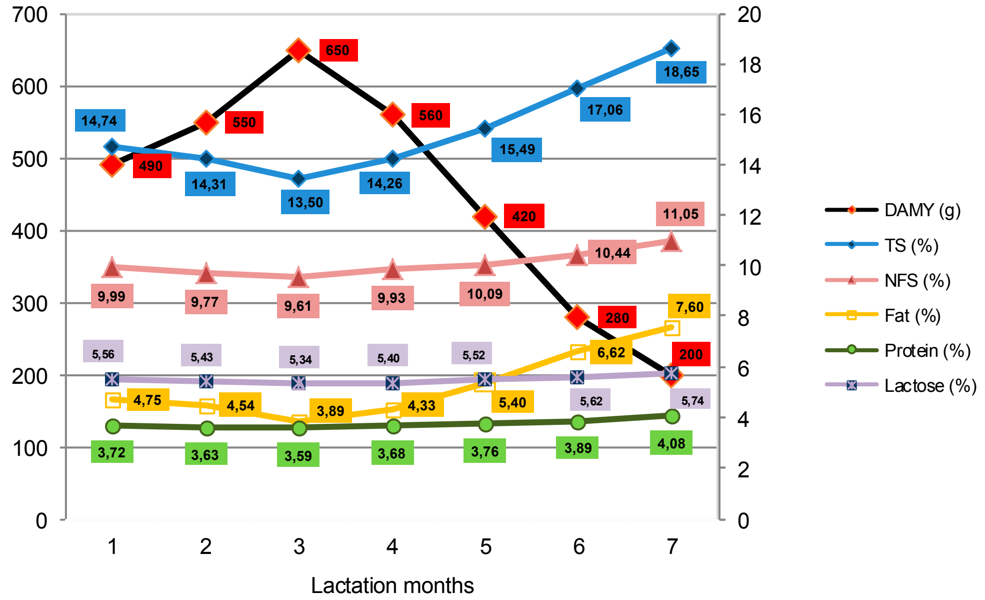

Photo 1: Hair buck; Photo 2: Hair doe; Photo 3: Hair male herd; Photo 4: Hair female herd (Source: Erduran H.)

Conclusions

Hair goats are a multipurpose breed, kept by farmers primarily to provide meat, milk and milk products. Any surpluses contribute to cash income from the sale of male yearlings and culled animals, acting as a form of insurance for resource-poor livestock producers in Turkey's highlands (Gursoy, 2005).

Turkey is one of the top countries in the world that raises goat. However, the extensive system generally practised in the country results in insufficient quantities of goat products because of low productivity.

In recent years, because of their nutritional value and economic importance, goat milk and its products have followed an increasing trend in developed and developing countries. In Turkey, too, goat milk products are being developed, along with alternative husbandry systems for goat management to increase the importance of goat milk (Senturklu and Arslanbas, 2010).

The results of this study imply that the high variation of milk yields among Hair goats could be the result of genetic variation. The milk yield traits of Hair goats may, therefore, be increased by selection or cross-breeding.

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GROWTH PERFORMANCE AND BODY MEASUREMENTS OF HONAMLI GOAT KIDS AS A NATIVE ANIMAL GENETIC RESOURCE UNDER BREEDER CONDITIONS IN TURKEY

Gök Bekir[45], Aktaş Ahmet Hamdi[45], Dursun Şükrü[46], Halıcı İbrahim[45] and Baş Hüseyin[45]

Abstract

This study was conducted on two Honamli goat herds protected as a native animal genetic resource and kept under breeder conditions in Antalya (herd 1) and Konya (herd 2) provinces in Turkey. In the study, birth weights (BWs), live weights (LWs), average daily gains (ADGs) and body measurements of 50 male and 50 female kids were determined.

Kids were suckled twice a day and fed on roughage up to weaning (at day 90). After weaning, they were grazed on pasture, bushes and forested areas. Concentrate feeds were not given to the kids.

The BWs and the LWs on days 90 and 180 of the Honamli kids were 4.42, 25.3 and 38.0 kg, respectively in herd 1, and 4.17, 24.5 and 35.3 kg respectively in herd 2. The ADGs of kids on days 0–90, days 91–180 and over the whole period (days 0–180) were 231, 142 and 187 g respectively in herd 1, and 226, 119 and 173 g in herd 2. There was no significant difference in ADG between the herds until weaning, but differences were significant on days 90–180 and over the whole period.

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The withers height, rump height, chest girth and body length at day 90 were 54.5, 54.9, 64.1 and 58.6 cm respectively in herd 1, and 53.9, 54.7, 65.9 and 57.6 cm in herd 2. The same traits at day 180 were 65.1, 66.3, 82.5 and 69.9 cm for herd 1, and 61.5, 63.4, 77.7 and 64.9 cm for herd 2. There were no significant differences in these measurements between the herds at day 90, but differences were significant at day 180.

Based on this study, it can be concluded that the growth rates and body measurements of kids in Antalya are superior to those of kids in Konya, and that the growth rates of Honamli kids are satisfactory under pasture conditions.

Key words: Honamli, kids, genetic resource, growth, body measurements

Introduction

It is recognized that animal genetic resources have essential roles in and value for food and agriculture, particularly in contributing to food security for current and future generations. The loss and erosion of these resources, therefore, poses a threat to food security and to the sustainable livelihoods of rural communities (FAO, 2007). The natural and economic conditions, agricultural structure and traditions of Turkey are generally suitable for sheep and goat farming, giving these sectors an important place in the country's agriculture (Anonymous, 2001). Goat farming can contribute to the sustainable use of forests, but these issues are still not fully understood in Turkey (Akbağ and Baytekin, 2010).

There are a total of 8 357 286 goats in Turkey, approximately 90 percent of which are of the Kıl (Hair) breed (TURKSTAT, 2014). In addition, limited numbers of Honamli goats are raised in the Taurus Mountains of southern Anatolia (Elmaz et al., 2012; Gök, Aktaş and Dursun, 2011). Goats are important farm animals in Anatolia. Raised by the Honamli nomadic people, Honamli goats are part of southern Anatolian culture, and the breed has been preserved by the nomads. Defining the characteristics of the Honamli breed in this area, and gathering information on its identification, protection and rural habitat will provide significant contributions to the world of science (Gök, Aktaş and Dursun, 2011).

The morphological and physiological characteristics of the Honamli have not been scientifically defined. Determination of these characteristics and the natural habitat of the Honamli goat as a native animal genetic resource are important.

The Honamli is a multi-purpose breed for (in order of importance) meat, milk and hair. The forehead and feet of pure-bred Honamli goats are white or brown, and the body is black, or occasionally streaked with grey. Horns in the male are curled and more developed than those in the female.

It has a big body and long legs. The tail is tufty and longer than that of the Hair goat. The ears are small and thick. An important feature is the convex nose. One of the characteristics of pure-breeds is the distance between the horns on the forehead, which should be 2 cm (GDARP, 2011).

In their study, Gök, Aktaş and Dursun (2011) found average values in male kids aged 90 days of 25.1 kg live weight, 65.9 cm withers height, 65.4 cm rump height, 66.2 cm chest girth and 66.7 cm body length. Those of female kids were 19.5 kg, and 61.8, 61.4, 62.6 and 62.8 cm, respectively. In another study (Elmaz et al., 2012b), these same traits were reported as 26.9 kg and 63.3, 63.3, 63.0 and 65.3 cm for male kids; and 23.4 kg and 60.8, 61.0, 60.0 and 63.1 cm for female kids.

The aim of this study was to investigate the growth performance and body measurements of Honamli goat kids protected as a native animal genetic resource kept under breeder conditions in Turkey.

Materials and method

In 2005, the General Directorate of Agricultural Research and Policy (GDARP) of Turkey's Ministry of Food, Agriculture and Livestock launched the "Animal Genetic Resources-Site Protection Project". The project was carried out by Bahri Dağdaş International Agricultural Research Institute on two protected Honamli goat herds in Gökçehüyük village of Seydişehir district in Konya Province (37° 25'39.91 N; 31° 48'36.62 E; 1 139 m above sea level) and Dereli village of Döşemealtı district in Antalya province (37° 5'46.55"N; 31° 0'39.31"E; 391 m above sea level). The protected goat herd comprised 224 adult females and 20 adult males. In this study, data of 50 male and 50 female kids were examined.

In the Honamli herd in Konya, feeding is based on pastures except for in the snowy winter period. In the period immediately before kidding, in snowy winter months, the goats were fed on straw and dry grass with a small amount of grain (200–250 g/day). After kidding, the goats grazed on pasture from April to October. In Antalya, winter-season feeding is on pasture or scrubland. In the two herds, kids grazed on mountain pasture after weaning, at altitudes of about 1 500–2 000 m.

This study measured the kids' live weights (LWs), average daily gains (ADGs) and body characteristics on days 90 and 180 after birth. The data were analysed by a General Linear Model (GLM) procedure using the Minitab program (Minitab Inc. 2011).

Results

Results regarding the LWs and ADGs of the kids are given in Table 1; body measurements are provided in Table 2.

As Table 1 shows, there were significant differences ($P < 0.04$-0.001) in LW, ADG and body measurements according to region and sex. The birth weights (BWs), LWs at day 180 and ADGs on days 90–180 and 0–180 were significantly higher in herd 1 than herd 2.

TABLE 1. LIVE WEIGHTS AND AVERAGE DAILY GAINS OF HONAMLI KIDS IN TURKEY (LSM ± SE)

		Live weight (kg)			Average daily weight gain (g)		
	n	Birth	Day 90	Day 180	Days 0–90	Days 90–180	Days 0–180
Region							
Antalya	50	4.42	25.3	38.0	231	142	187
Konya	50	4.17	24.5	35.3	226	119	173
SE		0.08	0.35	0.49	3.9	4.4	2.8
P		0.040	0.154	0.001	0.359	0.001	0.001
Sex							
Female	50	4.12	22.7	33.8	206	124	165
Male	50	4.48	27.1	39.5	251	137	194
SE		0.08	0.35	0.49	3.9	4.4	2.8
P		0.003	0.001	0.001	0.001	0.034	0.001
Region x sex							
Antalya female	25	4.23	22.7	35.1	205	138	172
Antalya male	25	4.61	27.8	40.9	258	146	202
Konya female	25	4.00	22.7	32.6	208	110	159
Konya male	25	4.35	26.4	38.0	245	129	187
SE		0.12	0.49	0.68	5.5	6.1	3.9
P		0.900	0.173	0.785	0.189	0.384	0.809

LSM = least squares means.
SE = standard error of mean.

TABLE 2. BODY MEASUREMENTS OF HONAMLI KIDS IN TURKEY AT DIFFERENT PERIODS (IN CENTIMETRES, LSM ± SE)

	Withers height	Rump height	Chest girth	Body length	Nose length
Day 90 (at the beginning of the pasture season)					
Region					
Antalya	54.5	54.9	64.1	58.6	15.4
Konya	53.9	54.7	65.9	57.6	14.5
SE	0.34	0.38	0.40	0.34	0.13
P	0.203	0.710	0.003	0.059	0.047
Sex					
Female	52.7	53.4	63.4	57.4	14.9
Male	55.7	56.2	66.5	58.8	14.9
SE	0.34	0.38	0.40	0.34	0.13
P	0.001	0.001	0.001	0.004	0.001
Day 180 (at the end of the pasture season)					
Region					
Antalya	65.1	66.3	82.5	69.9	17.3
Konya	61.5	63.4	77.7	64.9	16.3
SE	0.37	0.41	0.51	0.40	0.16
P	0.001	0.001	0.001	0.001	0.001
Sex					
Female	61.3	62.8	78.3	66.3	16.6
Male	65.4	66.9	81.8	68.5	17.0
SE	0.37	0.41	0.51	0.40	0.16
P	0.001	0.001	0.001	0.001	0.077

LSM = least squares means.

SE = standard error of mean.

At day 180, all of the body measurements of Honamli kids in herd 1 were significantly higher than those of kids in herd 2. At day 90, however, the differences were significant only for chest girth and nose length.

Discussion

Live weights of kids at different periods

The BW and the LWs at days 90 and 180 were 4.42, 25.3 and 38.0 kg respectively in herd 1, and 4.17, 24.5 and 35.3 kg in herd 2. By sex, the findings were 4.12, 22.7 and 33.8 kg for female kids, and 4.48, 27.1 and 39.5 kg for male kids.

Studies have been conducted to determine the growth performance of Honamli and Hair goat kids under extensive conditions in Turkey. One of these studies found BWs and LWs at day 90 of 4.3 and 19.5 kg for female kids, and 4.7 and 25.1 kg for male kids (Gök, Aktaş and Dursun, 2011); another found values of 3.7 and 20.4 kg for female kids, and 4.1 and 23.2 kg for male kids (Elmaz et al., 2012a).

Other studies investigating the growth performance of Hair goat kids under extensive conditions have found BWs of 2.77 kg (Şimşek and Bayraktar, 2006), 3.03 kg (Erten and Yılmaz, 2013), 3.12 kg (Erduran and Yaman, 2012) and 2.75 kg (Gökdal et al., 2013); LWs at day 90 of 16.1 kg (Şimşek and Bayraktar, 2006), 17.0 kg (Erduran and Yaman,

2012) and 12.4 kg (Erten and Yılmaz, 2013); and LWs at day 180 of 18.9 kg (Şimşek and Bayraktar, 2006), 26.8 kg (Erduran and Yaman, 2012) and 18.8 kg (Erten and Yılmaz, 2013). Gökdal et al., (2013) found LW at day 210 of 24.6 kg.

The BWs of kids in the current study were similar to the values found by Elmaz et al. (2012a) and Gök, Aktaş and Dursun (2011), but higher than those in most of the other studies cited.

The current study found LWs of kids at days 90 and 180 that were higher than those found in any of the other studies mentioned.

Average daily gains of kids

In this study, the ADGs of Honamli kids were 231 g on days 0–90, 142 g on days 90–180 and 187 g on days 0–180 in herd 1; and 226, 119 and 173 g respectively in herd 2. The ADGs of female kids in both herds were 206, 124 and 165 g respectively; and those of male kids were 251, 137 and 194 g.

Other studies have found ADGs for Hair goat kids during the pasturing period of 54–99 g (GDARP, 2011; Daskiran et al., 2010; Erten and Yılmaz, 2013). Daskiran et al. (2010) studied kids of another native pure-breed (Norduz) kept under extensive conditions and found an ADG of 132 g.

The ADGs of Honamli kids in this study were higher than those of the other studies mentioned, and similar to that of the Norduz kids.

Body measurements of Honamli kids

The study found withers height of 54.5 cm, rump height of 54.9 cm, chest girth of 64.1 cm, body length of 58.5 cm and nose length of 15.4 cm in Honamli kids at day 90 in herd 1; and measurements of 53.9, 54.7, 65.9, 57.6 and 14.5 cm respectively in herd 2. The same traits at day 180 were found to be 65.1, 66.3, 82.5, 69.9 and 17.3 cm in herd 1; and 61.5, 63.4, 77.7, 64.9 and 16.3 cm in herd 2.

In their study of Honamli kids, Gök, Aktaş and Dursun (2011) found withers height, rump height, chest girth, body length and nose length at day 90 of 65.9, 65.4, 66.2, 66.7 and 18.8 cm respectively in male kids; and 61.8, 61.4, 62.6, 62.8 and 18.4 cm in female kids. Elmaz et al. (2012b) found these measurements to be 62.3, 62.4, 62.2, 64.4 and 19.2 cm in the kids studied.

Studies of the body measurements of kids of other breeds in Turkey found withers height of 45.1 cm, body length of 43.0 cm and chest girth of 53.5 cm at day 90 in Hair goat kids (Şimşek and Bayraktar, 2006); and 48.7, 46.1 and 50.8 cm for the same traits in Kilis goat kids (Barıtcı and Eliçin, 2001). The same studies found measurements at day 180 of 52.6, 50.8 and 62.4 cm, and of 52.9, 50.9 and 56.8 cm respectively.

In the current study, the body measurements of Honamli kids at day 90 were generally lower than those found by Elmaz et al. (2012b) and Gök, Aktaş and Dursun (2011), but higher than the findings of Barıtcı and Eliçin (2001) and Şimşek and Bayraktar (2006).

The withers height, body length and chest girth of kids in this study at day 180 were also higher than those in the latter two studies.

Conclusions

These results show that Honamli goats have greater genetic capacity for rapid growth and live weight gain than the Hair goats reported in the literature. Honamli goats are also adapted to the harsh conditions of the Taurus Mountains. However, the population of these goats has decreased in the last 20–30 years because of weaknesses in the policies governing goat farming. The Honamli goat breed is an important animal genetic resource for Turkey, so ex-situ and in-situ conservation studies related to the breed should continue.

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CHALLENGES, OPPORTUNITIES AND DRAWBACKS IN INTENSIFYING GOAT FEEDING SYSTEMS IN THE CONTEXT OF CLIMATE-SMART AGRICULTURE

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Abstract

As a ruminant species, goats are able to valorize fibrous feeds and non-protein nitrogen to produce meat and milk in extensive feeding systems. They are also able to attain high production levels when they have the potential and receive a diet of high nutritive value. There is a trade-off between the cost of the diet and increased production, which needs to be evaluated in the context of climate-smart agriculture. Climate change may modify both the availability and the types of feed for ruminants, the animals' physiology and – thus – their requirements. Increasing levels of production can be achieved by increasing the percentage of concentrate feed in the diet. Intensification of feeding systems might modify feeding behaviour and have impacts on intake and rumen metabolism, increasing negative outputs of nitrogen or methane. All these aspects have to been taken into account when proposing new sustainable goat feeding systems.

Key words: goat; nutrition, intensification, climate-smart agriculture, feeding systems

Introduction

In extensive feeding systems, goats are able to valorize fibrous feeds and non-protein nitrogen in order to produce meat and milk. They also are able to reach high production levels when they have the potential and receive diets of high nutritive value in the non-limiting quantities that correspond to intensive feeding systems. Nowadays, it is also important to take into account the concept of climate-smart agriculture. According to FAO (2010), climate-smart agriculture is agriculture that sustainably increases productivity and resilience (adaptation), reduces or removes greenhouse gases (mitigation), and enhances the achievement of national food security and development goals.

The aim of this paper is to study the challenges, opportunities and drawbacks facing the intensification of goat feeding systems in the context of climate-smart agriculture, focusing on feeds, animals and feeding systems.

Feeds

Like cattle, goats are able to eat and valorize the available biomass from forage resources, crop residues, agro-industrial by-products and non-conventional feed resources. In all areas where goats are present or can be bred, it is important to know the availability, environmental constraints and nutritive value of feed resources so they can be matched to the animals' requirements under very different climates and locations.

Some agro-industrial by-products that are currently used rarely, such as pineapple bran, can also be valorized by ruminants instead of being discarded and becoming pollutants (Heuzé, Tran and Giger-Reverdin, 2013). However, they need to be used near where they are produced, because they are very rich in water and thus cost too much to transport or dry, unless they are sun-dried. They are also difficult to preserve. This example highlights the importance of conceiving integrated systems from the feed resources to the animals, including processing, distribution and consumption methods that do not incur prohibitive intermediary costs. However, in some countries, there is competition with other uses, such as biofuel generation, for some potential feeds, such as cereal by-products (Makkar, 2012).

Studies on the nutritive value of many plants exist, but most of them are dispersed and it is very difficult to synthesize the information – even when it can be collated – because the literature is heterogeneous in terms of both the information provided and the languages used (Morand-Fehr and Lebbie, 2004). In this context, an approach such as the recently established Web site Feedipedia (INRA et al., 2013) is valuable (Devendra and Leng, 2011). This open-source resource provides data sheets of information on the physical description of a wide range of feeds, their availability and environmental impacts, feeding recommendations and updated nutritional values for the main species of farm animals. Its first goal is to improve the identification and characterization of local feed resources to improve the technical and economic performance of farms. A key issue for ensuring the usefulness of this information is the need for accurate estimation of nutritive values, which must be based on standardized methods for all feeds, whatever their origins.

Some chemical methods are standardized well, such as the ash, crude fibre and nitrogen methods. However, the crude fibre method lacks precision in estimating the energy value of feeds and has often been replaced by the Van Soest method for lignin and cell wall estimations (Giger, 1985; Giger-Reverdin, 1995). However, the Van Soest method also has drawbacks because it was conceived for roughage with low starch, protein, lipid and tannin contents and requires amylolytic or other pre-treatments (Giger et al., 1987). There are now many variants of the Van Soest method and it is often difficult to compare results coming from different laboratories. Plants from hot countries might contain considerable amounts of tannins, which can also be measured by a large variety of methods (Schofield, Mbugua and Pell, 2001). Among the in vitro methods that mimic what happens in vivo, the HFT method of Menke (Menke et al., 1979) is valuable, but needs standardization and is especially useful for screening or comparing feeds (Long et al., 1999).

It is necessary to measure not only the energy and nitrogen values of feeds, but also other criteria, such as their mineral contents (deficiencies or excesses), palatability, and anti-nutritional factors such as saponins (Wang, Ye and Liu, 2012). Feeds have to be evaluated from a multicriteria point of view, examining a broad enough range of characteristics to allow nutritive values to be weighted according to local conditions, and periodically calibrating this evaluation against animal performances observed on farms. Even with traditional proximate analysis, some plants have a high nutritive value, but their growth and composition depend largely on agricultural constraints such as the climate (temperature and humidity throughout the year) and the soil quality (salty soils face specific constraints). Feed evaluation is further complicated by the interactions between feeds, which can be beneficial. Grass–legume associations are of practical interest from two points of view: legumes retain nitrogen in soils and improve soil fertility, while grasses decrease the overall degradation rate of the feed in the rumen and thus the risk of acidosis.

Global climate change will alter the local profiles of plants, with some plants becoming no longer viable while new opportunities arise for importing plants from other areas with similar agricultural constraints; these constraints must be taken into account before new plants are introduced, and competition with native plants also needs to be studied. It is also necessary to know the soil composition and its potential evolution under climate change. Projects such as the European e-SOTER[47] project should be developed all over the world. The relevant question is: What are the feeds available for goats in a specific area, and during which period of the year? It is necessary to know the nutritive value of these feeds at different stages of their development and to see whether a sufficient range of plants is available to sustain animal husbandry throughout the year, even in periods when food and water are scarce. If this can be achieved, production can be intensified over the years. As well as these technical points, the costs of the different diets should also be taken into account in the context of climate-smart agriculture.

Animals

Intensifying goat production in a context of climate-smart agriculture means increasing the feed efficiency along with the milk yield. The criterion generally used is the dry matter intake (DMI) per kilogram of raw milk yield (RMY), with DMI decreasing as RMY increases (Sauvant et al., 2012):

$$DMI/RMY = (0.39\ RMY + 1.21)/RMY \qquad (n = 147, RSD = 0.24)$$

Milk yield increases with the percentage of concentrate feed used, and the substitution of forage with concentrate (the decrease in the quantity of forage ingested when concentrate quantity increases) also needs to be taken into account (Sauvant et al., 2012). Digestive efficiency generally decreases when the intake increases, because the higher rate of passage limits degradation in the rumen. Even when general features of ingestion in ruminants are known, the specific features of ingestion in goats bred in different environments (from harsh to intensive ones) also need to be defined. For example, it is known that: some digestive interactions occur in the rumen; readily available starch

47 The e-SOTER project is a regional pilot platform established as the European Union's contribution to a global soil observing system. http://www.esoter.net

decreases fibre digestion; and goats are believed to be more efficient than sheep and, particularly, cattle in nitrogen recycling (Devendra, 1978). The digestive interaction and the specificity of goats have to be considered when evaluating feeds and either taken into account at the feed level (i.e. modification of the feed value when associated with other feeds) or the animal level (i.e. modifications of requirements). Based on information from a database of our laboratory, the response of milk yield to concentrate intake (DMIconc) is curvilinear (Sauvant et al., 2012):

RMY (kg/d) = 1.81 + 1.08 DMIconc (kg/d) – 0.17 DMIconc2

(n =189, nexp = 75, RSD = 0.25)

Milk composition is also modified: fat content decreases, while lactose content increases. Only protein content is not affected by an increase in energy input linked to an increased percentage of concentrate feed.

Chewing pattern is closely related to rumen pH (Desnoyers et al., 2011). In individual pens, goats fed the same diet can exhibit very different intake patterns, with consequences on rumen pH patterns and susceptibility to subacidosis. At the same level of intake (expressed in terms of body weight), goats presenting a long period of intake had a rapid drop in rumen pH after feeding, below the threshold of 6.0 under which feed degradation in the rumen is impaired (Oetzel, 2000). This was not the case of goats that alternated feeding and ruminating bouts (Desnoyers et al., 2011). These goats also produced about 170 g more milk per kilogram of DMI, and thus likely contributed more to total farm income over feed costs through milk sales (Giger-Reverdin, Sauvant and Duvaux-Ponter, 2013). More research is needed on phenotyping, especially chewing behaviour in relation to nutritional efficiency, and to identify the origins of these differences in feeding patterns.

Methane emission is another important factor to take into account when intensifying production. Methane production is highly dependent on rumen metabolism, and particularly on volatile fatty acid stoichiometry (Sauvant et al., 2011). The emission of this greenhouse gas per kilogram of animal product (meat or milk) will become increasingly important, whatever the feeding system considered. However, the greenhouse gas effect needs to be considered not only at the animal level, but also at a larger scale, including all the factors involved in production, such as pastures or fields that sequester carbon, and carbon emissions from the tractors used in cereal production or from fertilizer manufacture (Boadi et al., 2004; Cottle, Nolan and Wiedemann, 2011).

If the climate changes or water or feed shortages occur, the physiology of the animals will also change and their requirements will be modified (Silanikove, 2000); the importance of these modifications and the ability of the animals to cope with climate change or water restriction depend on the breed (Silanikove, 1985).

Feeding systems

The intensification of feeding systems needs to define inputs and animal requirements more precisely. In France, the Systali project involves about 30 researchers in updating the energy (UF) and protein (PDI) systems for ruminants (Sauvant and Nozière, 2013). Its target is to predict animal responses to very different diets and/or feeding systems. Most of the differences among diets depend on what happens in the digestive tract, especially the rumen. The project is based largely on interpreting large databases obtained from INRA and meta-analyses of the literature (Sauvant et al., 2008; St-Pierre, 2001). The methodology used is to study the meta-designs, especially their representativeness, the orthogonality among variates and experiment encoding. The latest update revisits five main points:

1. The transit outflow rates of feeds and water are a function of DMI expressed on a live-weight basis (DMI/LW) and of percentage of concentrate (PCO).
2. Digestive interactions are due to three factors: DMI/LW, PCO, and rumen protein balance (RPB). They are applied to the digestibility of organic matter (OM) and outflows of urine and methane.
3. Prediction of starch and protein degradation in feed is based on in situ measurements and validated when possible by in vivo duodenal flows.
4. Fermentable organic matter (FOM) in the rumen is defined as being closer to the true OM ruminal digestibility, taking into account digestive interactions.
5. Microbial protein flow at the duodenum is expressed as a function of PCO, RPB and FOM.

The major responses of digestion were integrated in a simple mechanistic model of the gut to check the consistency across all the equations. Outputs of the model were prediction of the flow of nutrients (volatile fatty acids, gas, glucose, fatty acids, essential amino acids) and prediction of the animals' responses to these flows, such as the links between nitrogen intake and nitrogen fluxes in dairy goats (Sauvant et al., 2012). This updating of the feeding system provides an opportunity for improving goat husbandry as it allows better comparisons among feeding systems and selection of the system that is best adapted to the given context.

In contrast to digestive efficiency, overall production efficiency increases with the level of feeding if the increase in intake translates into increased productivity, because there is a dilution of maintenance costs. Thus, efficiency is affected not only by intake but also by nutrient partition, i.e. the proportion of nutrients channelled to production relative to other life functions. Nutrient partitioning has been studied mainly in dairy cows (Friggens et al., 2013) with relatively little information or focus on small ruminants. This is an important limitation on the ability to manage nutrition efficiency in small ruminants. The counterpart of digestive efficiency is the excretion of potentially polluting factors such as nitrous oxide (Reynolds, Crompton and Mills, 2011), or increasing greenhouse gases such as methane (Sauvant et al., 2011). However, faeces and urine can increase soil fertility (Devendra, 2001), and methane can be used as a heat source on some intensive farms. Calculating global benefits is, therefore, far from easy, and will rest on multicriteria evaluation of feeds, considered in terms of local conditions.

Even when useful research has been carried out at experimental stations, it has had no positive impact for small farmers unless it has been disseminated, transferred and adapted to the farm context by extension services (Goetsch and Girma, 2009; Wadha and Bakshi, 2013). Farmers will accept a change in husbandry methods only when it is practicable and economically beneficial. This is a key point – not only for goats – for increasing the efficiency of research to benefit humanity.

Conclusions

Intensifying goat feeding systems in the context of climate-smart agriculture concerns more than the nutrition area. Other factors to be taken into account include feed availability, agricultural constraints, breed availability, farmers' knowledge, and society's demand for animal welfare and climate-smart agriculture.

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SHORT WATER RESTRICTION EPISODE IN LACTATING ALPINE AND SAANEN GOATS

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Abstract

This project aimed to assess the effect of a short episode of water restriction on high-producing lactating goats. Water was withheld from eight Saanen and eight Alpine goats from immediately after the afternoon milking until the following morning on two consecutive days. Water and feed intake, body weight and major blood parameters were assessed daily for a day before, during water restriction, and for two days after. Milk production and composition were also measured daily. The results showed that the animals experienced some dehydration as a result of the treatment, although they maintained a total water intake similar to the control values recorded on day 1. A drop in feed intake was observed on the days of water restriction, but body weight was not affected. Several blood indicators also pointed to the state of dehydration that the animals were experiencing: increases in albumin, urea, osmolality and sodium (Na+). The goats maintained milk production, but milk composition was altered: milk urea and lactose contents increased under water restriction thus keeping milk isotonic with the blood. The observed changes reflect the activation of mechanisms that limit body water loss and prevent further dehydration. It was concluded that high-producing goats were able to sustain two short consecutive cycles of dehydration and rehydration, as indicated by their maintained body weight and milk production, with only transient physiological and milk changes.

Key words: Alpine, Saanen, lactation, water restriction

Introducton

Goat production is an important economic activity in Europe and in rural areas around the world, where it is practised mostly under extensive systems with high dependence on natural resources and environmental conditions (Jaber, Chedid and Hamadeh, 2013). Heat waves and water shortages are becoming more common, including in Europe where temperate weather used to prevail. Goat breeds show great variability in their

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adaptations to these conditions. On the one hand, breeds that are native to arid and semi-arid regions have been well studied and show high resilience to heat and drought through special adaptive mechanisms that include high renal water retention, rapid water replenishment on rehydration with slow release into the bloodstream to prevent haemolysis, and minimization of water loss for evaporative cooling (Abdelatif, Elsayed and Hassan, 2010; Silanikove 2000; 1994). On the other hand, European breeds have rarely experienced these conditions in the past and are now being challenged in both their native countries and the countries to which they are exported because of their high productivity. This project aimed to assess the effect of two consecutive periods of water restriction on the physiology and production of Saanen and Alpine goats in mid-lactation raised in their native European climate.

Materials and methods

The experiment was conducted on the experimental farm of the research unit of INRA-AgroParisTech MoSAR (Thiverval-Grignon, France; 48° 51′ N; 1° 55′ E; 70 m above sea level). Eight Alpine and eight Saanen goats (160 days in milk [DIM] at the start of the experiment) were included. The animals were housed in metabolic cages and were well adapted to the experimental setting (including housing, feeding and human manipulation), which was applied from 20 days prior to the beginning of the experiment. The experiment lasted for five days during which water was offered ad libitum during the first day, withheld from immediately after the afternoon milking until the following morning on days 2 and 3 (15 hours of restriction), and offered ad libitum on days 4 and 5. The animals had free access to feed which was composed of dehydrated lucerne (30 percent on a dry matter basis), meadow hay (20 percent), pressed sugar beet pulp (30 percent) and compound concentrate feed (20 percent). The feed was offered ad libitum, making sure that 10 percent was left over; feed quantities were readjusted accordingly, on a weekly basis.

Individual water and feed consumption were measured daily, along with body weight, rectal temperature and milk production. For half of the goats, urine and faecal output was measured on the first three days of the experiment. Daily milk samples were analysed for fat, protein, lactose and urea content. Jugular blood samples were taken each morning, before offering fresh water and feed. A blood gas and mineral analyser (ABL 77, Radiometer, Copenhagen, Denmark) immediately determined sodium (Na^+). Plasma was harvested and stored at −20 °C until assays for glucose, non-esterified fatty acids (NEFA), albumin and urea were carried out using a Cobas Mira-Analyzer (Roche, Mannheim, Germany) with commercial kits for glucose (Gluco-quant, Glucose/HK, Roche Diagnostic, Mannheim, Germany), NEFA (NEFA-HR[2], Wako, Chemical GmBH, Neuss, Germany), albumin (80002, Biolabo, 02160, Maizy, France) and urea (Urea/BUN, Roche Diagnostic, Mannheim, Germany). Osmolality was determined with a MARK3, radiometer analytical SA osmometer (manufactured by Fiske® Associates, Norwood, Massachusetts, Untied States of America) applying a method based on the depression in the critical freezing point. Environmental temperature and humidity were recorded three times a day.

The data were analysed by paired-t test using the IBM-SPSS Statistics 21 software. Day 1 was used as the control for each animal and was compared separately with each of the subsequent days of the experiment.

Results and discussion

The water restriction regime caused a significant decrease in water intake (Table 1) on the first day of restriction (day 2 of the experiment). However, on days 4 and 5, water consumption exceeded the control level. This could indicate a reaction of overcompensation whereby the animals tend to drink large volumes of water in anticipation of future water shortage episodes. In this experiment, the water drunk in the morning straight after rehydration was more than twice the amount taken on the day of normal watering: 2.88 litres (normal) on day 1 versus 6.4 and 6.8 litres on days 2 and 3, respectively. Such behaviour was previously observed in arid-adapted breeds and denotes the capacity to tolerate rapid rehydration without risking haemolysis (Jaber et al., 2014; Silanikove, 1994). Another factor that could explain the increase in water consumption is the observed increase in ambient temperature during the experimental period, from 15.6 to 19.1 oC in the morning, and from 19.0 to 23.3 oC in the afternoon. This increase in ambient temperature was also reflected by higher rectal temperatures (Table 1), although the temperature range remained within the thermo-neutral zone of the animals (Giger-Reverdin and Gihad, 1991). The increase in water consumption may have been needed for cooling in response to the added heat load.

In contrast, the animals reduced their feed intake under water restriction (Table 1). This response is widely observed in small ruminants, which need water for proper digestive function (Hadjigeorgiou et al., 2000); it is thought that this is to prevent feed accumulation and compaction in the digestive tract. However, the animals' body weight seemed to increase throughout the experimental period, which may indicate that water consumption has a greater effect on body weight than feed consumption during the short term of this experiment.

TABLE 1. WATER AND FEED INTAKES, BODY WEIGHTS, RECTAL TEMPERATURES AND FAECAL AND URINE OUTPUTS OF LACTATING SAANEN AND ALPINE GOATS SUBJECTED TO TWO SUCCESSIVE 15-HOUR PERIODS OF WATER RESTRICTION

Parameter	**Day 1**	**Day 2[1]**	**Day 3[1]**	**Day 4**	**Day 5**
Water intake (litres)	7.26 ± 0.301	6.41[2] ± 0.301	6.85 ± 0.282	8.04[2] ± 0.359	8.32[2] ± 0.381
Feed intake (kg)	5.45 ± 0.129	5.02[2] ± 0.127	5.00[2] ± 0.134	5.29[2] ± 0.136	5.40 ± 0.140
Body weight (kg)	60.6 ± 1.82	61.4 ± 2.19	62.02 ± 1.86	63.12 ± 1.96	62.52 ± 1.99
Rectal temperature (oC)	38.54 ± 0.056	38.70[2] ± 0.044	38.80[2] ± 0.044	38.84[2] ± 0.050	38.83[2] ± 0.057
Wet faecal material output (kg)	3.30 ± 0.171	3.45 ± 0.209	3.45 ± 0.143		
Faecal material dry matter (%)	27.3 ± 0.71	29.2[2] ± 1.02	28.5[2] ± 0.69		
Urine output (litres)	1.11 ± 0.089	0.89[2] ± 0.089	1.25 ± 0.124		

1 Water removed directly after the afternoon milking until the next morning.

2 Means are significantly different from day 1 ($P < 0.05$)

Water restriction led to a decrease in urine output during the first day. In contrast, the faecal output was not significantly affected (Table 1), but faecal dry matter content increased. These observations indicate that the animals activated their water conservation mechanisms at the level of the kidneys and through the digestive tract, to minimize water loss and further dehydration. Highly adapted sheep breeds have been reported to produce very small amounts of highly concentrated urine when subjected to prolonged water restriction (Laden, Nehmadi and Yagil, 1987). The Alpine and Saanen goats of this experiment seem to show similar trends in short-term water restriction episodes.

The water restriction protocol applied in this experiment was effective in causing the physiological signs of dehydration as commonly reported in the literature (Table 2). The first sign was the increase in blood albumin observed on days 3 and 4, following water restriction and just before watering. This increase denotes a reduction in blood volume, whereby blood water may have been circulated to other body compartments to maintain normal function (Jaber et al., 2014; Mengistu, Dahlborn and Olsson, 2007). Blood Na+ and urea also increased under water restriction. Previous studies have indicated that increase in these parameters is a sign of the activation of water conservation at the level of the kidneys, as Na+ and urea reabsorption by the nephrons leads to water reabsorption (Mehta, 2008). This also explains the previously observed decrease in water urine output. The increase in blood electrolytes, in turn, causes an increase in osmolality, which is observed in this experiment as in the literature (Dahlborn, 1987; Mengistu, Dahlborn and Olsson, 2007). It is worth noting that osmolality, urea and albumin dropped slightly below the control levels on day 5, following 24 hours of rehydration. This could indicate that the animals maintained the over-drinking behaviour for one day after the water restriction episode, probably in anticipation of possible future restrictions. It was previously reported that small ruminants may show a slow return to normal blood composition on rehydration, although they ingest large volumes of water as an adaptation to prevent haemolysis (Jaber, Chedid and Hamadeh, 2013). The slightly lower values observed on day 5 indicate a return to normal blood volume, or perhaps more than normal blood volume because of the water influx from the rumen. It would be interesting to evaluate the blood rehydration status in relation to the urinary output in order to assess whether kidney function was restored simultaneously to rid the body of the excess water.

TABLE 2. BLOOD CHEMISTRY PARAMETERS IN LACTATING SAANEN AND ALPINE GOATS SUBJECTED TO TWO SUCCESSIVE 15-HOUR PERIODS OF WATER RESTRICTION

Parameter[1]	Day 1	Day 2[2]	Day 3[2]	Day 4	Day 5
Glucose (g/litre)	0.583 ± 0.0054	0.583 ± 0.0112	0.625[3] ± 0.0167	0.612[3] ± 0.0075	0.571± 0.0071
NEFA (mmol/litre)	137± 6.6	136 ± 6.4	133.00 ± 4.771	127± 3.3	125 ± 4.2
Urea (g/litre)	0.256 ± 0.0171	0.235 ± 0.0148	0.331[3] ± 0.0169	0.397[3] ± 0.0280	0.250 ± 0.0136
Albumin (g/litre)	43.43 ± 0.371	43.98 ± 0.358	46.04[3] ± 0.523	44.61[3] ± 0.382	42.78 ± 0.342
Osmolality (mOsm/kg)	294 ± 0.6	293 ± 0.7	306[3] ± 0.9	307[3] ± 0.7	2923 ± 0.5
Na+ (mmol/litre)	142 ± 0.3	143[3] ± 0.4	149[3] ± 0.4	148[3] ± 0.5	143 ± 0.3

1 Blood was sampled in the morning before offering feed and water.
2 Water removed immediately the afternoon milking until the next morning.
3 Means are significantly different from day 1 ($P < 0.05$).

The glucose and NEFA results (Table 2) seem to indicate a status of positive energy balance during water restriction although the animals decreased their overall feed intake. It could be speculated that the significant increase in glucose on days 3 and 4 is an indication of altered eating patterns by the thirsty animals, which caused the surge in glucose at the time of measurement, while under normal watering the animals would delay eating until fresh feed and water were offered. Previous reports on glucose levels under dehydration are inconclusive, but it is generally noted that a decrease in feed intake usually leads to a decrease in glucose levels (Jaber, Chedid and Hamadeh, 2013). Behavioural observations on the timing of feed intake under water restriction are needed to clarify the results obtained in this experiment. The NEFA tended to decline over the experimental period, further denoting that the animals were in positive energy balance (Jaber et al., 2011), which may also explain why no weight loss was observed.

Milk production was maintained under water restriction, with a slight surge in production on day 5 (Table 3), but lactose and urea tended to increase following water restriction on days 3 and 4. It was previously observed that lactose plays an important role in keeping the milk isotonic with the blood (Dahlborn, 1987). Therefore, in view of the increased blood urea, albumin and osmolality, the changes observed in milk composition are a reflection of changes in the blood. Similarly, the surge in production and the slight drop in major milk components on day 5 may be another reflection of a transient state of over-hydration as noted above, whereby the animals tended to produce a larger, but more dilute, volume of milk. Milk fat was not significantly affected by water restriction but seemed to decline slightly throughout the experimental period. Alamer (2009) reported a decrease in the fat content of milk in 25-percent water-restricted goats, while those that were 50-percent restricted maintained normal fat content. Longer-term experiments may be helpful in determining the effect of water restriction on milk composition of high-producing European goats.

TABLE 3. MILK PRODUCTION AND COMPOSITION OF LACTATING SAANEN AND ALPINE GOATS SUBJECTED TO TWO CONSECUTIVE 15-HOUR PERIODS OF WATER RESTRICTION

Parameter	Day 1	Day 2[1]	Day 3[1]	Day 4	Day 5
Milk production (litres)	3.61 ± 0.119	3.59 ± 0.108	3.57 ± 0.110	3.60 ± 0.110	3.73 ± 0.107
Milk fat (g/kg)	33.1 ± 1.07	33.0 ± 1.056	32.78 ± 1.137	32.3 ± 1.05	32.0 ± 0.87
Milk protein (g/kg)	31.9 ± 0.58	31.6[2] ± 0.56	31.8 ± 0.59	31.6 ± 0.46	31.5[2] ± 0.52
Lactose (g/kg)	43.8 ± 0.36	43.8 ± 0.37	44.6[2] ± 0.41	44.1 ± 0.45	43.5[2] ± 0.37
Milk urea (g/kg)	0.567 ± 0.0142	0.536[2] ± 0.0141	0.592± 0.0199	0.596 ± 0.0182	0.517[2] ± 0.0167

1 Water removed immediately after the afternoon milking until the next morning.
2 Means are significantly different from D1 ($P < 0.05$).

Conclusions

This experiment demonstrated the capacity of high-producing Alpine and Saanen goats to adapt to a short-term water restriction regime. Although signs of dehydration were observed, these signs were temporary and did not seem to affect the overall status of the animals, as attested by their maintained body weights and milk production. Longer-term studies would be interesting to assess the effect of such watering regimes over an extended period; in addition, behavioural data on water and feed intake would be helpful in explaining all aspects of these breeds' adaptability to water shortage.

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CHALLENGES TO THE DEVELOPMENT OF A RURAL GOAT INDUSTRY IN SOUTH AFRICA

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Abstract

The efficiency of most livestock species, including goats, has improved at a staggering rate over the past three decades. The development of livestock has focused mainly on increasing productivity and income, with major impacts on the commercial sector. However, the benefits for the informal, rural goat sector have been limited. One of the main causes of this situation is the relatively low numbers of goats (typically fewer than ten) owned by each small-scale farmer/household and the fact that these animals are not usually kept with the primary objective of selling them. Insufficient and poorly managed grazing land, animal diseases, drought and stock theft are additional constraints to production. The dualistic nature of South Africa's agriculture sector creates a difficult environment in which young people (especially young black South Africans) are reluctant to pursue a career. The wide wealth gap between rural and urban areas also reduces the attractiveness of this sector. To develop the rural goat industry efficiently, the role of goats in the agricultural system first needs to be defined, then specific markets for value-added products need to be developed. Policy for the development and sustainable management of rangeland commons needs to be integrated with broader land reform, while the smallholder sector needs a comprehensive overhaul. Research actions should be integrated with development and have the commitment of governments and development agencies.

Key words: smallholder system, communal, indigenous goats

Introduction

Animal products contribute roughly 45 percent of the total gross value of agricultural production in South Africa (Department of Agriculture, Forestry and Fisheries, 2013). Although South Africa is a large country by European standards, almost 80 percent of agricultural land is suited only to semi-extensive and extensive farming systems. Cattle, sheep and goat farming utilize approximately 580 000 km^2 in this manner.

FAO (2012) estimates that the South African goat population consists of about 6.2 million animals. The majority (approximately 63 percent) of these goats are unimproved indigenous animals in the non-commercialized agriculture sector, kept in small-scale farming conditions (Rumosa Gwaze, Chimonyo and Dzama, 2009). These goats do not participate in a recording scheme, and without official statistics their exact numbers are difficult to determine (Directorate: Marketing, 2007). The majority of the South African goat population is found in the Eastern Cape, followed by Limpopo and KwaZulu Natal. The Eastern Cape is home to an estimated 910 000 Angora goats (Directorate of Marketing, 2010), which supply more than 50 percent of the global mohair clip (Visser et al., 2011). The remaining 1.3 million goats are mainly of the improved meat breeds – Boer, Savannah and Kalahari Red. Commercial dairy goats are in the minority, with fewer than 4 000 heads registered with the South African Studbook.

The indigenous goats kept in smallholder and communal systems are well adapted to the semi-arid and arid, harsh environments. The pastoral level is characterized by resource-poor farmers who are under constant threat from environmental factors such as drought and floods (Peacock and Sherman, 2010). Herds in these systems normally consist of hardy indigenous goats, adept at foraging in degraded environments. However, village goats are generally neglected by stakeholders, including veterinarians, researchers and extension officers. The aim of this paper was to review the challenges facing the development of a rural goat industry in South Africa.

Role of indigenous goats

Archaeological evidence indicates that goats had migrated to southern Africa by 2500 BCE because of increasing desertification of southern regions of the Sahara (Maree and Plug, 1993). It is believed that the local Khoisan people travelling south from northern Botswana down to the Orange River brought goat herds (Campbell, 2003). These goats had a wide variety of colours and colour patterns and are referred to as speckled goats. They were most likely the genetic resource for development of the local meat-type goats found in South Africa.

The reason for the popularity of goats in developing countries, apart from their hardiness, lies in their value as social currency and the reduced risk associated with smaller animals compared with cattle (Ahuya et al., 2005; Peacock, 2005). As a small ruminant able to use a wider range of forage, goats may be preferred to cattle, as more goats can be kept and cared for on a piece of land that may be able to support only one bovine. There is a lower inherent risk in keeping goats compared with other livestock; if a goat is lost to disease, predators or theft, the smallholder will still have a few goats left, whereas loss of a single cow would leave him/her with no animal resources. Goats are often seen as a form of "fluid capital", as animals can easily be sold to cover immediate expenses such as school fees or fodder purchases for the rest of the herd (Kosgey and Okeyo, 2007; Peacock, 2005).

Smallholder production systems

Most of the meat-producing goats in South Africa are kept in communal farming systems. Although 84 percent of communal land has potential only for grazing, livestock production in this system contributes very little to the agriculture economy (Bembridge and Tapson, 1993).

Herding

Herding is one of the most common methods of goat rearing in South Africa. The goats are usually herded during the day and penned at night (Rumosa Gwaze, Chimonyo and Dzama, 2009). Schoolchildren are usually responsible for herding goats – thus, the school timetable influences animal management. Grazing practices differ among villages, depending on the abundance of veldt. If plenty of grazing is available, individual herds are usually kept separately, but if grazing is limited, all the goats in the village might graze together as one large herd. In these cases, the animals interbreed randomly. Regardless of the abundance of veldt, the poor quality and limited availability of feed limit production. Usually, there is a complete absence of supplementary feed, and crop residues are considered a luxury.

Tethering

Tethering of animals is quite common in rural areas. Tethered goats are secured with a rope tied to a peg, preventing them from destroying crops and freeing the farmer from watching them (Rumosa Gwaze, Chimonyo and Dzama, 2009). Tethering is sometimes practised when goats are herded (e.g. during school time). This system limits the feed available to the animals, as they are not free to roam, and usually results in poor body condition and parasite infestation.

Challenges for development

Although goat production in rural areas has potential for contributing to food security and commercial development, it faces several challenges. The main challenges applicable to goats in South Africa are discussed in the following.

Limited management

Poor management of goats affects production in different ways. Goats in smallholder systems are not usually housed properly and are exposed to extreme weather conditions (Rumosa Gwaze, Chimonyo and Dzama, 2009). In addition, the goats do not receive supplementary feed and are dependent on natural veldt. The harsh environment in which the goats are kept can lead to severe feed shortage. Herding and tethering systems result in high parasite infestation and prevalence of diseases. Veterinary care is limited or completely unavailable to most of these farmers, leading to high mortality rates, low reproductive rates and subclinical diseases (Gebeyehu et al., 2013).

Poor and/or inappropriate grazing management hinders goat productivity. Animals are often subjected to seasonal undernourishment and an absence of supplementary feeding prevails. Severe water shortages are also not uncommon.

Policy, participation and technological change

It is widely acknowledged that smallholder production is in need of technological change (Iñiguez, 2011). Enhancements that should receive attention include, but are by no means limited to, range management, feeding systems and herd health management, efficiency of production, and use of unconventional feeds. To implement changes successfully, a coherent vision and alignment of policy with broader land reform needs to take place (Vetter, 2013). Research is needed to support technical aspects, but will not succeed in bringing about a change on its own. Significant, sustainable investments from the government and development agencies are crucial to ensuring the implementation of successful technologies.

South Africa has a history of a dual agricultural production system with a highly developed commercial livestock sector and a resource-poor subsistence and smallholder sector. Since 1990, the government has committed to developing agricultural policy that provides for an integrated rural development strategy (Nel and Davies, 1999). Despite these efforts, research based on one of South Africa's larger regions where goats are kept indicated that small-scale producers still face several challenges. In addition to the aspects mentioned with regard to the availability of grazing and veterinary support, small-scale farmers also have insufficient land and/or market access. Marketing in the communal areas is characterized by absent or ill-functioning markets (Rumosa Gwaze, Chimonyo and Dzama, 2009). Most goats are sold in informal markets and transactions are not captured in official statistics.

The sustainability of a development programme also depends on the willingness and agreement of farmers (Wurzinger, Solkner and Iñiguez, 2011). The lack of participation from farmers in many projects is the result of several factors, such as the exclusion of farmers' views when developing project goals, the short-term outputs required by researchers and the limited number of participants per research project. Farmers' roles should not be limited to that of informants to researchers; they should, instead, be viewed as key stakeholders.

Youth bias

In South Africa, about 8.5 million people depend on agriculture for their employment and income. The government's New Growth Path aims to create job opportunities for 300 000 households in smallholder agriculture schemes, and 145 000 jobs in agroprocessing. These jobs will have the potential to upgrade conditions for 660 000 farmworkers by 2020 (Department of Government Communications and Information Systems, 2012). It has been suggested that small-scale agriculture could become the developing world's single biggest source of employment (Swarts and Aliber, 2013).

Despite this optimistic outlook from the government, young people do not view agriculture as an attractive career. Although this is an Africa-wide problem, the situation in South Africa is particularly severe. The South African agriculture sector has a distinctly dualistic nature, with commercial farmers on the one hand and communal, small-scale and subsistence farmers on the other. The wide wealth gap between rural and urban areas also tends to make farming unattractive. In general, farming is perceived as a low-status job. Agriculture is often seen as comprising only agrarian work, while the range of professional and entrepreneurial opportunities along the value chain is ignored. Many of the young people active in agriculture are there not out of interest in agriculture, but because it is expected of, or even forced upon, them (Swarts and Aliber, 2013).

Approaches to addressing this problem include targeting youth and drawing them into specific agriculture-focused programmes, and making agriculture more attractive, mainly by making it more remunerative. The rangeland commons pose a particular challenge in that older farmers dominate local agricultural communities, outcompeting young people (Vetter, 2013). Overstocking in these areas contributes to the problem, leaving little space for commercialization, which could be a solution for increasing economic efficiency and making agriculture a more lucrative career option.

Genetic resources

According to Campbell (1995) the true indigenous goat of South Africa has been crossbred to near extinction through the development of local meat-type goats such as the Boer. Breeds such as the Kalahari Red and Savanna have also been subjected to artificial selection for improved production and growth, in line with the requirements of commercial goat production. The challenge now lies in selecting for sustainable production under extensive farming conditions. This selection should include emphasis on maintaining the strong characteristics of local breeds with regard to their adaptive capacities for relatively poor nutrition and their superior ability to survive tick-borne diseases compared with commercial goat types (Erasmus, 2000; Malan, 2000).

A genetic analysis of the three locally developed breeds (Boer, Kalahari Red and Savanna) based on microsatellite markers indicated that their genetic variation differs, with heterozygosity values ranging from 57 percent for the South African Boer goat to 68 percent for the Kalahari Red (Pieters et al., 2009). In a study of unimproved feral Tankwa goats and Boer goats from different regions of South Africa, average heterozygosity values were 66 and 56 percent, respectively (Kotzé et al., 2014).

Indigenous populations are often associated with and named after geographical regions, with limited breed definition. Phenotypic characteristics such as ear length and horn shape dictate the selection and there is a lack of pedigree and production information (Yapi-Gnaoré, Dagnogo and Oya, 2001). This creates the risk of losing breed authenticity when indiscriminate cross-breeding takes place. Cross-breeding is often the result of a lack of infrastructure, extension support or record-keeping, which is beyond the control of smallholders and goat keepers. The inevitable result is that genetic resources may be lost before they have even been discovered.

Despite the constraints discussed in this paper, South Africa has the advantage of having locally developed breeds that are recognized and already used in commercial farming. The government has stated its support for development and expansion of the goat industry. There are formal marketing channels for goat meat, which can be altered to include the current informal sector, and a support body (the National Emergent Red Meat Producers' Organization – NERPO) aims to commercialize this developing agricultural sector and ensure meaningful participation of black South African farmers in the mainstream commercial agribusiness sector; hence, ensuring the long-term sustainability of the agriculture sector in South Africa.

Conclusion

There is no doubt that several challenges must be overcome for rural goat keeping to develop into viable small-scale production. The commercial sector for goat meat and fibre is well established, and indigenous goat types are recognized in South Africa and included in research and conservation programmes. There are many lessons from which to learn about rural goat production. South African goat farmers should have opportunities to develop from being goat keepers for household food security to becoming small-scale goat producers as a commercial industry.

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DATA ON THE IMPORTANCE OF GOAT MILK AND MEAT IN HUMAN NUTRITION

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Abstract

The authors of this paper sought to summarize the importance of goat meat and milk in human nutrition and to raise goat milk and meat products to their proper place, emphasizing their functional properties and special taste, aroma and palatability. Awareness of goat milk and meat is much higher in several other European Union (EU) and non-EU countries than it is in Hungary. Goat milk is safe and free of tuberculosis pathogens; in the past – when milk was not heat-treated – goat milk was already being used as a safer food than cow milk. In some regions, it was used as medicine because it has effective health properties, such as increasing general resistance. Today it has been confirmed that goat milk can be digested easily, is rich in minerals and essential amino acids, and has very high nutritional value. Goat dairy products now have a notable place in modern healthy nutrition and can be considered functional foods, especially when the animals are raised in organic conditions. Goat meat is also very valuable, having a low fat content and being very palatable. It has a delicate, sweet taste, so with the right seasoning excellent dishes can be prepared. Food products originating from goat milk and meat, particularly different cheese specialities, can enrich the menus of festivities and holidays.

Key words: healthy food, organic food, human nutrition, organic breeding, goat

Introduction

Goats are ancient inhabitants of the Carpathian Basin, they were brought to Europe by previous generations. However, they found goats already in Hungary; the Hungarian conquerors are known to have consumed goat milk and meat frequently, and may have used other raw materials originating from goats (Hungarian Sheep and Goat Breeders' Association, 2014).

Hungary does not attach much importance to goat milk and dairy products, unlike other

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countries with major goat husbandry such as France, Spain, Greece and the Netherlands, which could be role models for Hungarian goat farming.

In the post-Second World War period, a few generations grew up with goat milk as their basic food. In some regions of Hungary, goat milk was also used as a therapeutic food because of its general resistance-enhancing effects. Goat milk is easy to digest and rich in vitamins, minerals and essential amino acids, making it a valuable source of nutrients. It is recommended for children, elderly people and people recovering from illness or with digestive disorders.

Goat cheeses made from domestically produced milk are now readily available in the Hungarian market, alongside more expensive imported (e.g. French) goat cheeses. Many of the Hungarian cheeses are of excellent quality, having a clear taste and proper texture, with adequate shelf-life and a "goat flavour" that is not as intense as that of imported cheeses. Food products originating from goats are welcomed by a gourmand group of Hungarian consumers. International recognition of Hungarian goat dairy products is also increasing (Polgar and Toldi, 2011).

Goats have very high milk producing capacity. Normally, during a lactation period, a goat can produce several times its own weight in milk. This is a very important property from an economic point of view.

Regarding animal husbandry, goats have several biologically and economically positive characteristics, such as rapid growth, high progeny, high adaptability and resistance against extreme climate and environmental conditions (Ferenczy, 2011).

Materials and method

Goat milk

Healthy human nutrition for the protection of health requires proper food preparation. Milk is one of the main foods for humans. Milk and dairy products are very important not only in childhood, but for adults and elderly people. Milk is a source of energy, with easily digested proteins, vitamins and minerals, including the calcium that is necessary for bone. It should be mentioned that about 10 percent of Hungary's population suffers from osteoporosis (Kukovics, 2001).

This paper summarizes the positive nutritional effects of goat milk, meat and goat food products, emphasizing their significant role in the diversity of human nutrition.

Consumers have better knowledge of the composition of cow milk than of goat or sheep milk. The milk of small ruminants shows larger variation in composition as a consequence of the animals' feeding. The foraging of cattle is more uniform, while the variety of feeds consumed by small ruminants results in variation in the fat, protein, vitamin and mineral contents of their milk. The significance of the good vitamin (e.g. B12), folic acid and iron contents of goat milk should be emphasized.

Milk is one of the human foods containing the most bioactive materials. The bioactive components of milk fat are effective in the fight against cancer, and the multifunctional effects of bioactive milk proteins are also very valuable. These components can be agonistic, antagonistic, immune stimulating, immune modulating, binding of fatty acids, vitamins or minerals, epithelial regenerating, anti-hypertensive, anti-thrombotic, anti-carcinogenic, anti-microbiotic and/or anti-atherogenic. Whey proteins are richer in bioactive compounds than casein. Lactose is very valuable because of its prebiotic (lactitol, lactulose) content, which can enhance the growth of probiotics and serves as an adjuvant in the metabolism of calcium. The most important mineral in milk is calcium, which has major roles in preserving the integrity of bones and teeth and preventing colorectal cancer and renal calculus. One of the positive characteristics of milk is that its potassium content is three times higher than its sodium content. Its selenium content has an antioxidant effect, reducing the risk of cancer and arteriosclerosis and the ageing process. The protecting effects of milk vitamins are also well known. Vitamins B6 and B12 and folic acid have important roles in preventing hyperhomocysteinaemia and arteriosclerosis. Milk also has a significant role in maintaining the acid-base equilibrium of the human body, and milk is protected from the prions of bovine spongiform encephalitis (Kukovics, 2001).

Goat meat

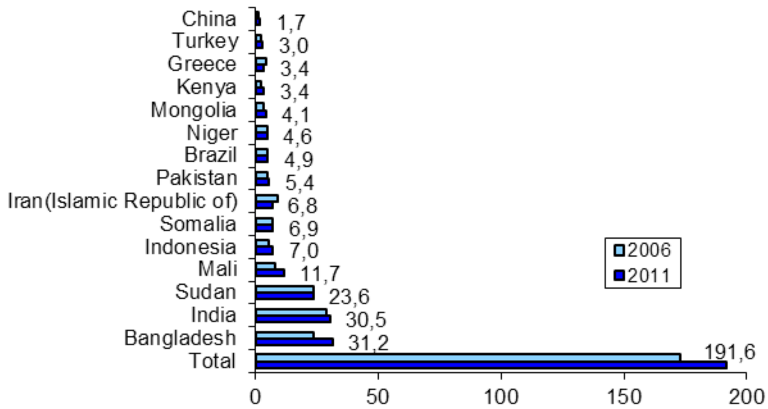
Goat meat is a very palatable food and has several positive physiological effects and nutritional values. It can be prepared in various ways, but the most usual is fried or stuffed and roasted. Goat meat is slightly sweet, so requires careful seasoning. A very pleasant taste and aroma can be obtained from frying goat meat and cheese together. The melted cheese on the surface of the meat creates a truly gastronomic speciality. The best meat yield is from kids of eight to ten weeks old. This meat can be prepared in various ways: fried in slices or whole, stuffed and roasted and as schnitzel, stew or goulash. With curing or when soaked in milk or spiked with bacon, particularly palatable dishes can be prepared (Hungarian Sheep and Goat Breeders' Association, 2014).

Results and discussion

After meat production, milk production is the largest and most efficient sector of goat husbandry. Regarding data published by FAO in 2013, goat milk was in third place in worldwide milk production in 2011. Cow milk was in first place, with the highest quantities, and buffalo in second place, dominating mainly in Asian countries. Goat milk has an important role in Asian and African countries, but also in Europe, even though it accounts for only a fraction of total milk production. Sheep milk production is more than the half that of goat milk, while camel milk has started to increase in recent years in Arab countries. The most important goat milk producing countries in Europe are Greece, France and Spain (Kukovics, 2013).

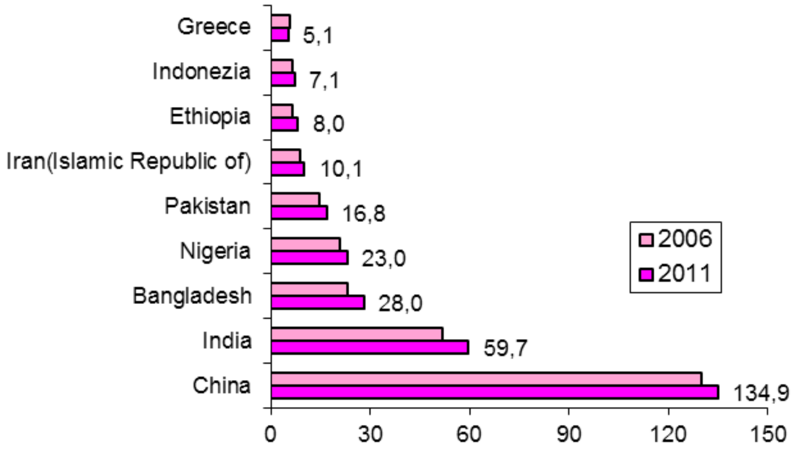
FAO statistical data for 2011 show that the global population of milk-producing goats (Figure 1) is nearly half as large as the meat-producing goat population (Figure 2).

FIGURE 1. WORLD MILK GOAT PRODUCTION (MILLIONS)



The biggest goat milk-producing countries are India, Bangladesh and the Sudan. The most important meat producers are China, India and Bangladesh. In Europe, Greece is the most important for both milk and meat goat products (Figures 1 and 2) (FAO, 2014).

FIGURE 2. WORLD MEAT GOAT PRODUCTION (MILLIONS)



China is the biggest goat meat producer, with more than 400 million meat goats; however, its milk goat population is far smaller, at 1.7 million animals (FAO, 2014). In numbers of animals slaughtered, Asia is in first place, followed by Africa. Meat production in Europe and America is much lower, and figures for Oceania are negligible, although Oceania exports large quantities to Asia, Africa and Europe (Kukovics, 2013).

Consumers can select from a wide variety of goat dairy products. In the European Union (EU) there are two trends in cheese production technology. In the Netherlands, Denmark and Germany, the dairy industry produces huge quantities of goat cheeses processed with precisely engineered and controlled technologies. In the United Kingdom of Great Britain and Northern Ireland, Switzerland and France, speciality cheeses are manufactured on small farms under organic conditions, following traditional recipes. The most well-known products are the different kinds of cheese and yoghurt. Goat cheese production has undergone strong development; various cheeses are produced from goat milk, sometimes mixed with sheep or cow milk. To manufacture 1 kg of cheese, 10 litres of milk is needed. Traditional French goat cheese is manufactured from goat milk only. The largest quantity of goat cheese worldwide is made in France. In Greece, there are few pure goat cheeses; goat milk is usually mixed with sheep milk to obtain a piquant, distinctive flavour. The product development of cheeses is currently increasing sharply. Soft cheeses manufactured in the United Kingdom of Great Britain and Northern Ireland are flavoured with nuts, green spices, herbs and garlic. Consumers in Greece and Bulgaria prefer mainly hard cheeses. Spreadable and Roquefort-type cheeses are very popular in France. Fermented products are manufactured mainly in the Middle East, Greece and Turkey, but can also be found in Canadian and American markets. There is no industrial production of goat yoghurt in the EU because the special, intense aroma is not readily appreciated by EU consumers (Szigeti, 2005).

Goat milk is processed by only a few small or larger dairy plants in Hungary (such as Alföldi Garabonciás, Magyarkanizsai and Léda goat milk processing plants and Dióstanya pilot plant). Processing plants have to overcome several difficulties, such as the dispersion of breeding farms, and competition with products imported from other EU and neighbouring countries (e.g. Slovakia and Romania), which are readily accepted by Hungarian consumers. Nevertheless, there are some positive developments in Hungary, such as the newly developed probiotic products and their novel processing technologies (Szakály and Unger, 1998).

Cow milk is usually the raw material for probiotic dairy products. Goat probiotic products are novelties, enhancing the positive characteristics of goat milk. These probiotic products have several effective nutritional and health values. They contribute to the normal digestive process, have anti-carcinogenic and cholesterol-lowering effects, and aid lactose decomposition in cases of lactose intolerance. Fermented goat dairy products manufactured with inulin have no strong goat flavour, which is a great advantage for consumers who reject goat products because of their intense goat aroma.

The behaviour of consumers in preferring or rejecting goat cheese depends largely on the consumer's first experience of goat cheese and the kind of cheese it was. Some consumers will like the cheese's special spicy taste enough to want to invest in having it. Others might have a negative experience and be put off by the intense and striking aroma. Experiences may be positive when the first cheese tasted has been professionally manufactured from carefully processed goat milk. The maturing process gives goat cheese a richer and more piquant taste, so for younger and newer consumers, fresh goat cheeses with a light aroma are recommended.

Among the consumers of organic products there is a strong consumer base committed to goat cheese. Higher prices are often a barrier for consumers, but in the case of goat dairy products, price is proportional with value. Goats produce significantly less milk than cows (about a tenth as much), but in both cases 10 litres of milk is necessary to obtain 1 kg of cheese. The nutrition factors of goat milk are also very favourable compared with those of cow milk. It is easy to digest and has a better composition and beneficial effects on bone health (Szigeti, 2005).

Goat milk contains slightly less lactose than cow milk; consumers with lactose intolerance can consume fermented products, which have significantly less lactose in their composition. Goat milk is rich in fats and has slightly more essential fatty acids than cow milk, but this difference is not significant (Table 1). Fatty acids play an important role in the functioning of the immune, nervous and cardiovascular systems and the prevention of several diseases. Goat milk contains more fatty acids of medium chain length (C4–C10), which represent easily and rapidly utilizable energy resources, despite their reduced absorbing surface (Webbeteg, 2013).

TABLE 1. COMPARISON OF GOAT AND COW MILK CONTENTS

Milk (100 g)	Energy (kcal)	Protein (%)	Fat (%)	Essential fatty acids (%)	Cholesterol (mg)	Carbo-hydrates (%)
Goat	70	3.6	3.9	0.12	11	4.7
Cow (2.8% fat)	60	3.4	2.8	0.13	10	5.3

Compared with cow milk, the fat content of goat milk is dispersed into much smaller globules, making it easier to digest because it is more accessible to the digestive enzymes. The butter manufactured from goat milk maintains its white colour even when the goats are fed on green forage because the beta-carotene is transformed into vitamin A. This process does not occur in cow milk, so cow milk butter is yellowish because of the presence of carotene. The lack of vitamin A in some cow milk may be compensated for by drinking goat milk, which contains more vitamin A (Table 2). Goat milk also contains higher quantities of water-soluble (B1, B2, B6, D, C) and fat-soluble (E, K) vitamins. It also has the effect of converting carcinogen substances into less harmful ones, so might be used as a preventive food. Goat milk can be consumed by most people with casein intolerance; goat milk casein precipitates into smaller flakes than cow milk casein, making it more digestible. Goat milk also has higher amino acid content: 0.2 litres can provide the daily amino acid requirements of an adult.

Goats need a diversity of feed, so they consume a wide variety of plants. This feature can be exploited by feeding them medicinal herbs to obtain milk with therapeutic properties. Last but not least, it is worth mentioning that the whey of goat milk is widely used by the cosmetic industry (Hungarian Sheep and Goat Breeders' Association, 2014).

TABLE 2. VITAMIN CONTENTS OF GOAT AND COW MILK

Milk (100 g)	A (µg)	C (mg)	D (µg)	B1 (µg)
Goat	60	5	0.25	50
Cow (2.8% fat)	15	1	0.02	35

Compared with cow milk, goat milk contains higher quantities of potassium, sodium and phosphorous, but less magnesium.

All parts of the goat can be used, but some Hungarian consumers have an aversion to consuming goat meat. Hungarian farmers have been breeding goats and sheep for several centuries, but there are few traditional ways of processing and marketing milk and meat products. However, developments are now being made in this field: supermarkets have started to distribute goat cheeses, although goat meat is still rarely available on the market. The fat tissues of goats, unlike those of sheep, are not incorporated into the muscle tissue, so goat meat does not contain tallow. The high nutritive value of goat meat has been proved. Lean meat without fat is easy to digest, so can be used for weight-loss diets. Despite all of these positive effects, however, many people do not want to consume goat meat. Goat meat is healthy and palatable; its taste can be compared with that of sheep meat, but experts regard it as tastier. Goat meat is very delicious when prepared as stew or just fried (Kocziha, 2009).

The goat meat on the market generally originates from young animals, mainly as a by-product of milk production. Younger animals are slaughtered because consumers do not favour the strong taste and smell of older animals. The slaughter weight for goats is about 30 kg, which is reached at the age of 18–24 weeks, depending on feeding conditions. The meat of older animals is darker and tougher, and the fatty tissues are yellow. The yield of lean meat is high in goats because of the lack of subcutaneous fat.

It should also be mentioned that some goat species are bred for their very valuable fleeces, which are used in the textile industry; these are the so-called “fibre goats”. Cashmere and angora goats are bred for their long, wavy hair and coat. Angora goats produce silky mohair, which comes from their undercoat. Cashmere goats are dual-purpose fibre and meat goats. The meat of cashmere kids is darker than that of other species (Swatland, 2004). Red meats have higher biologically active haemoglobin content. The haem-iron is more accessible and helps the metabolism of non-haem iron. Table 3 presents data on typical goat meat composition (Casey, 1992).

TABLE 3. MEAN COMPOSITION OF GOAT MEAT (CONCENTRATION OF MINERALS IN MG/100 G)

Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Ca	P	Mg	K	Na	Cu	Zn	Fe	Mn
64.2	29.2	4.7	0.87	11	155.5	19.7	350	64.5	0.3	3.5	4.4	0.09

Conclusions

Goat food products represent an important nutrient source, especially for consumers in developing countries, which account for more than 90 percent of the estimated world goat population. For Western consumers, goat food products – particularly dairy products – are considered luxuries. Consumer trends are currently undergoing important changes as foods with special quality traits become increasingly popular. Goat meat and dairy products have high nutritional values and fulfil the expectations of consumers who prefer special quality and organic food products. Goat food products contribute to an enjoyable and healthy human diet, enriching it with their variety.

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BODY CONDITION AND MILK PRODUCTION ON FIVE SAANEN GOAT FARMS IN HUNGARY

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Abstract

This study examined the body condition of Saanen goats on five farms, registering the milk yields, numbers of kids, dates of birth and ages of does. The aim was to discover how body condition changes during lactation, how these changes affect milk production and which body conditions achieve the best milk yields in the different periods of lactation. The study examined 37 does on farm 1, 17 does on farm 2, 45 does on farm 3, 17 does on farm 4, and 80–90 does on farm 5.

Based on their examinations, the study authors concluded that the most milk per lactation was produced on farm 1, where the body condition score (BCS) was 2.5 at the beginning of lactation, about 3 in mid-lactation, and 3.3 at the end of lactation (r = -0.18). The more the other farms differed from these body condition data the less milk they produced.

On farm 5, a BCS heritability of h2 = 0.20 ($P < 0.05$) was found, which is low (poor heritability). When considering milk yield, a value of h2 = 0.22 ($P < 0.05$) was found in the goats on farm 5, meaning that this parameter also indicated poor heritability.

Environmental impacts have large roles in body condition and milk production, and should be considered during breeding work.

Key words: goat, body condition, milk production, heritability

Introduction

The ideal body condition score (BCS) varies depending on gender and age. For does during their dry period, the ideal BCS is between 2.75 and 3.5; at kidding it is 2.75–3.5; at the start of lactation (days 0–45) it is about 2; and for the rest of lactation a BCS of 3 is the most appropriate (Meyers-Rabon, 2004). Cabbidu et al. (1999) found a negative

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correlation between the average body condition and milk yield (r = -0.24) throughout lactation; this correlation was minimal at the start of lactation, but had grown (to r = -0.39) by the end. The BCS is a suitable measure for assessing the energy state of goats, and forage problems (Bertoni and Cappa, 1984).

The ideal BCS changes during the year: in the early reproduction period it is 2 or 3 in female goats (Spahr, 2004).

Materials and methods

This study examined the body conditions of Saanen goats on five farms, registering the milk yields, numbers of kids, dates of birth and ages of does. There were 37 does on farm 1, 17 on farm 2, 45 on farm 3, 17 on farm 4, and 80–90 on farm 5. On all farms, grazing was supplemented with feed mix at morning and evening milking, but the qualities and quantities of the grazed and supplemented food differed. The study calculated the body conditions of the animals on each farm at the monthly milking, measuring the milk quantity with a Berango-type milk measure. The study also examined the heritability of BCS and milk yield.

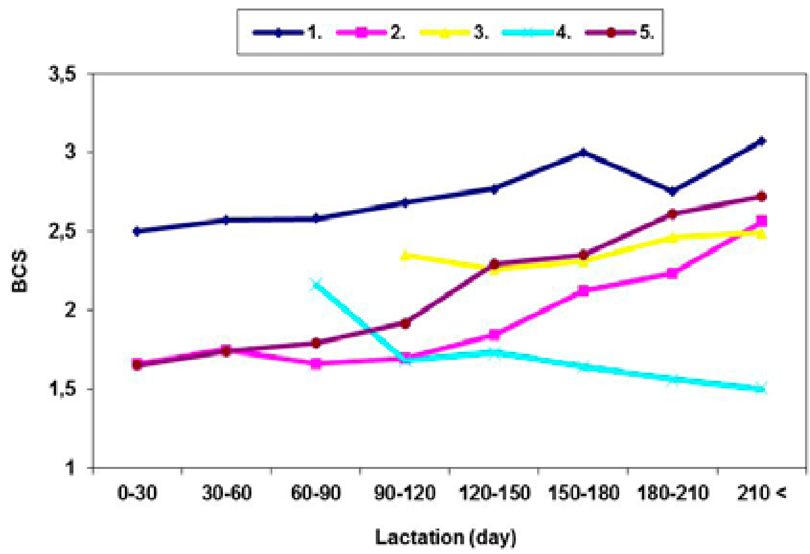
Microsoft Excel 5.1 was used to collate the data, and the SPSS for Windows 15.0 program for data processing. One-factor variance analyses and Pearson correlations were applied to the calculations.

Results and discussion

Milk production and body condition

Figure 1 shows that the animals on farm 1 were in the best condition throughout the period examined. Farm 1 was also in the first place for milk production (Figure 2). The BCS on farm 1 was 2.5 at the beginning of lactation, 2.5 around day 90 of lactation, increasing to 3, and 3.3 by the end of lactation. With these BCS, a doe was producing 2.5 kg of milk a day at the beginning of lactation, and 2.25 kg at the end.

FIGURE 1. CHANGES IN BCS THROUGHOUT LACTATION ON FIVE FARMS IN HUNGARY



The BCS on farms 3 and 5 were similar from day 120, increasing slightly without any significant deviation. Milk production (Figure 2) values on these two farms also converged, with no considerable differences. It should be noted that these values approach those of farm 1, implying that conditions on farms 3 and 5 were also suitable for milk production.

On farm 2, during the first part of lactation animals produced a lot of milk despite their weak body condition; however, these animals were soon exhausted, and from about day 120 milk production decreased significantly (Figure 2), dropping increasingly below production on farms 1, 3 and 5. BCS on farm 2 improved after day 120, but remained lower than on farms 1, 3 and 5 (Figure 1).

The worst values for both condition and milk production were found on farm 4, and were considerably different from those on the other farms. The animals on farm 4 were in such poor condition that the milk production decline after day 210 (to 0.36 kg/day/doe) did not improve their condition.

FIGURE 2. CHANGES IN MILK PRODUCTION THROUGHOUT LACTATION ON FIVE FARMS IN HUNGARY

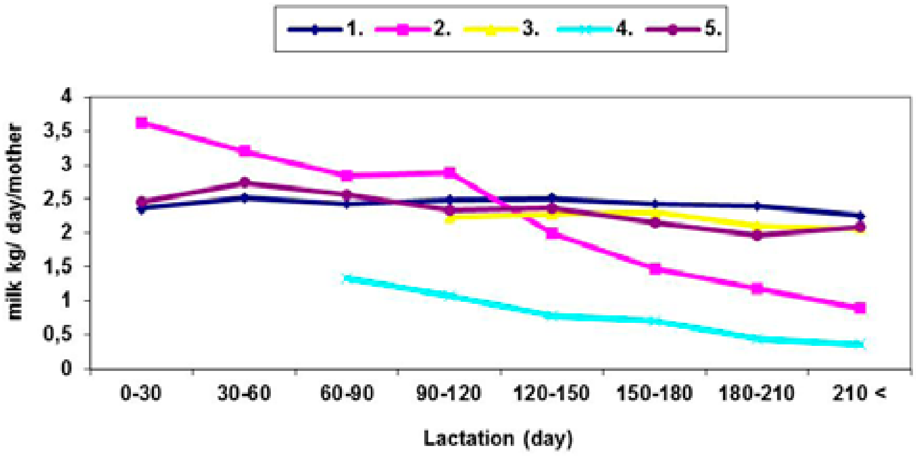


TABLE 1. CHANGES IN BCS THROUGHOUT LACTATION ON FIVE FARMS IN HUNGARY

Lactation period (days)	x̄ ± s				
	Farm 1 n = 37	Farm 2 n = 17	Farm 3 n = 45	Farm 4 n = 17	Farm 5 n = 80
0–30	2.50 ± 0.55 a	1.66 ± 0.62 b	-	-	1.65 ± 0.79 b
30–60	2.57 ± 0.56 a	1.75 ± 0.50 b	-	-	1.74 ± 0.69 b
60–90	2.58 ± 0.48 a	1.6 ± 0.56 b	-	2.16 ±0.39c	1.79 ± 0.68 b
90–120	2.68 ± 0.68 a	1.69 ± 0.54 b	2.35 ±0.61 a	1.68 ± 0.41 b	1.92 ± 0.76 b
120–150	2.77 ± 0.73 a	1.84 ± 0.50 b	2.26 ± 0.68 c	1.73 ± 0.49 b	2.29 ± 0.75 c
150–180	3.00 ± 0.80 a	2.12 ± 0.59 bc	2.31 ± 0.62 b	1.64 ± 0.45 c	2.35 ± 0.72 b
180–210	2.75 ± 0.72 ab	2.23 ± 0.53 b	2.46 ± 0.56ab	1.56 ± 0.40 c	2.61 ± 0.77 a
> 210	3.07 ± 0.75 a	2.56 ± 0.67 abc	2.49 ± 0.52 a	1.50 ± 0.40 d	2.72 ± 0.70 c

x ± s = mean ± standard deviation.
a, b, c, etc.: different letters in the same lactation period denote significant differences among means.

Table 1 shows the precise values of BCS and indicates (with letters) where there were significant differences among farms in a single lactation period. It is clear that goats on farm 1 were in significantly better condition than those on the other farms at the beginning of lactation; it is only between days 180 and 210 that values on the other farms approached those of farm 1, meaning that there were no significant differences, with the exception of farm 4.

TABLE 2. CHANGES IN MILK PRODUCTION THROUGHOUT LACTATION ON FIVE FARMS IN HUNGARY

Lactation interval (days)	x̄ ± s (2)				
	Farm 1 n = 37	Farm 2 n = 17	Farm 3 n = 45	Farm 4 n = 17	Farm 5 n = 80
0–30	2.36 ± 0.67 a	3.63 ± 0.84 b	-	-	2.45 ± 0.46 a
30–60	2.52 ± 0.82 a	3.20 ± 0.53 b	-	-	2.74 ± 087 a
60–90	2.42 ± 0.77 a	2.84 ± 0.60 a	-	1.33 ± 0.45 b	2.57 ± 0.85 a
90–120	2.49 ± 0.75 ab	2.88 ± 1.41 a	2.23 ±0.68 b	1.08 ± 0.42 d	2.34 ± 0.99 b
120–150	2.51 ± 0.78 a	2.00 ± 0.76 b	2.28 ± 0.67ab	0.79 ± 0.43 d	2.37 ± 0.92 ab
150–180	2.42 ± 0.80 a	1.48 ± 0.49 b	2.30 ± 0.58 a	0.70 ± 0.45 d	2.15 ± 0.68 a
180–210	2.39 ± 0.32 a	1.19 ± 0.60 b	2.10 ± 0.62 ac	0.45 ± 0.35 d	1.97 ± 0.60 c
> 210	2.25 ± 0.69 a	0.89 ± 0.35 b	2.06 ± 0.58 a	0.36 ± 0.19 b	2.09 ± 0.91 a

x ± s = mean ± standard deviation.
a, b, c, etc.: different letters in the same lactation period denote significant differences among means.

Table 2 shows where there were significant differences between farms in milk production in a given lactation period. Farms 1 and 5 started with almost identical levels at the beginning of lactation. Production on farm 2 was significantly higher. Between days 150 and 180, the values on farms 1, 3 and 5 did not differ significantly from each other, but they differed from those on farms 2 and 4, which also differed largely between themselves.

Correlation between milk production and body condition

On farm 1 the study did not find a considerable correlation between body condition and milk production at the beginning of lactation, because neither value changed significantly (Figure 1). The BCS remained within the ideal range, so did not influence milk production, which showed a smooth curve. However, between days 150 and 180, milk production decreased and body condition improved, implying a negative correlation (r = -0.35). The does were in good body condition in the other lactation periods, so the BCS did not influence milk production (Table 3).

On farm 2, the correlation at the beginning of lactation was positive and averagely strong (r = 0.50) (Figure 2). From day 120, it showed a negative correlation, which got gradually stronger between days 180 and 210 (r = -0.43), meaning that the decrease in milk production resulted in improvement of body condition (Table 3). These values demonstrated the typical physiological characteristic of milk goats, showing that they are capable of producing a large amount of milk even at the cost of their own body condition, but not for long.

TABLE 3. CORRELATIONS BETWEEN BCS AND MILK PRODUCTION ON FIVE FARMS IN HUNGARY

	Farm 1 n = 37	Farm 2 n = 17	Farm 3 n = 45	Farm 4 n = 17	Farm 5 n = 80
0-30	-0.07	0.17	-	-	-0.19
30-60	-0.17	0.50	-	-	0.05
60-90	-0.15	0.38	-	0.11	-0.14
90-120	-0.08	-0.05	-0.07	0.27	0.06
120-150	-0.16	-0.24	-0.16	0.13	0.10
150-180	-0.35	-0.39	0.15	0.46	-0.19
180-210	-0.11	-0.43	-0.07	0.51	-0.21
210 <	-0.14	-0.32	0.08	0.62	-0.38

On farm 3, no correlation was apparent, because of the slight change in factors, with good body condition similarly to that of farm 2. The body condition was suitable, so it did not influence milk production.

On farm 4, the correlation was positive and got continuously stronger because both body condition and milk production decreased. Between days 90 and 120, the correlation was r = 0.27, rising to r = 0.62 between days 210 and 240. In such a physically weak stock, even the decrease in milk production did not improve body condition.

These results support the literature in holding that animals' BCS should not be allowed to drop below 2. However, a question arises regarding how, on farm 2 – where the body condition was similarly weak – the does were able to produce well in the first half of lactation.

Milk production, like all other physiological processes, is complicated; many factors influence it, including the number of kids. Of the 17 does on farm 2, six had three kids, while none of the does on the other farms had as many. In does giving birth to triplets, the quantity of placental lactogen, which affects development of the mammary glands, is much greater because there are three placentas. As a result, far more milk is produced, even in animals in bad body condition.

On farm 5 there was no significant difference in either body condition or milk production until about day 130 of lactation; this explains the lack of correlation between these values on farm 5. However, from day 150, milk production started to decrease and condition improved, showing a negative correlation, which became gradually stronger after day 210 (r = -0,38) (Table 3).

The heritability of BCS and milk yield

In the examined stock (farm 5), a BCS heritability of h2= 0.20 (P < 0.05) was found, which is a low value (denoting poor heritability), and lower than the values described by other authors. Veerkampf, Koenen and De Jong (2001) found a value of h2 = 0.38 in goats. Gallo et al. (1999) determined the BCS heritability values in a wider range, of h2 = 0.24–0.45.

When considering milk yield, a value of h2 = 0.22 (P < 0.05) was found on farm 5, meaning that the heritability of this parameter is also poor. Boichard et al. (1989) found a value of h2 = 0.31 in Saanen goats. The values given by Kennedy, Finley and Bradford (1982) varied by species and type, from 0.19 to 0.68.

The deviation from data in the literature suggests that environmental impacts have a large role in the development of body condition and milk production, and should be considered during breeding work.

Conclusions

From comparisons of the body condition and milk production of animals on the five farms, the study concluded that the BCS on farm 1 was the most ideal for milk production. BCS on farm 1 was 2.5 at the beginning of lactation, 2.7 around day 90, before rising to 3, and 3.3 at the end of lactation.

The greater the differences between these and the BCS on other farms, the lower the milk production on these farms. After farm 1, the animals in the best body condition were on farms 5 and 3, which did not have any significant deviances from each other after day 120. Farm 2 came next, and finally farm 4. The same ranking can be seen with regard to milk production.

This conclusion is consistent with data found in the literature (Spahr, 2004; Meyers-Rabon, 2004). When the animals' condition is kept at a suitable level, milk production also stays at a suitable level throughout lactation, showing a persisting lactation curve (farms 1, 3 and 5). It is typical that there is a correlation between body condition and milk production only at the end of lactation. The decrease in milk production results in improvement of the body condition, leading to a negative correlation ($r = -0.38$).

Some animals with low BCS (1.7) were capable of considerable milk production for a short period at the beginning of lactation, implying that on average, body condition influenced milk production strongly (on average, farm 2 had a correlation of $r = 50$, and farm 4 of $r = 0.40$).

It can be concluded that the BCS method can be applied well to milk producing Saanen does, and may serve to improve milk production results. The heritability of BCS and milk yield were found to be weaker than average, and their values can be significantly affected by environmental factors (feeding according to needs).

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THE NORWEGIAN HEALTHIER GOATS PROJECT

Dag Lindheim[56] and Liv Sølverød[56 57]

Abstract

Norway is a country of mountains, fjords and long distances. Driving the 2 500 km from the north to the south of the country takes about 30 hours. Milk-producing goat herds are located all over Norway, particularly in mountain areas. Kidding usually lasts from December to March, and goats produce milk from mountain pastures during the summer. The mean herd size was 105 goats and the average milk yield 730 kg in 2013.

Goat production in Norway has changed over the last 15 years. Today's 300 milk-producing herds of approximately 40 000 milking goats (versus the 1 000 herds of 15 years ago) produce 20 million litres a year. The number of meat producing herds is increasing slightly. In 2013, the total goat population of Norway was 68 000 heads.

Introduction

TINE SA is a Norwegian dairy cooperative owned by 14 000 farmers (of cows and goats). Its 36 dairy facilities process 1 475 million litres of cow and goat milk a year. TINE accounts for 95 percent of the national raw milk market and regards animal health and welfare as an important aspect of milk quality, for both goats and cows.

Photo 1. Goats on a mountain "holiday", Norway (Source: Lindheim, 2014)

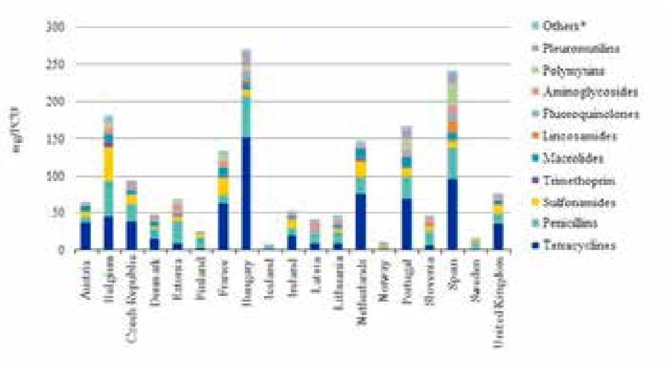
56 TINE SA Advisory Service, Goat Health Service, Norway
57 TINE SA Advisory Service, TINE Mastitis Laboratory, Molde, Norway

Norwegian goats and cows have unique identification numbers associated with their livestock herds. TINE has created a health system for cows and goats. Every farm has a health card for each animal on which to register diseases and medical treatments in the herd. Production data (mating, delivery, milk yield, milk composition, etc.), health records, the use of medicines, and the quality parameters of milk production are registered in a single database at TINE. Information on the drugs administered is also reported to the Norwegian Food Safety Authority. Records are collected into Web reports, enabling each farmer to access the reports for her/his animals online on the TINE Web site.

Photo 2. Goats on their way from milking to mountain pasture, Norway (Source: Lindheim, 2014)

TINE's strategy is to manage infectious diseases through prevention using minimal amounts of antibiotics (Figure 1). Believing that it is possible to eradicate and control infectious diseases, the cooperative's members seek to eliminate infections rather than introducing large-scale vaccination programmes in milk-producing animals. Building farmers' knowledge of everyday biosecurity measures, and providing advice on restricted trade in animals are important keys to success. Farmers' associations are working with the authorities on these issues.

FIGURE 1. EUROPEAN MEDICINES AGENCY (EMA) REPORT FROM 2012



In 2012, the European Medicines Agency (EMA) reported that Norway used 3.7 mg of antibiotics per kilogram of meat produced, compared with more than 150 mg/kg in Hungary, Spain, Belgium and Portugal.

A goat health survey was performed in 2000 in response to the increased clinical disease problems and decreased milk yields recorded over the previous 25 years. The prevalence of caprine arthritis encephalitis (CAE) was 88 percent, measured by the presence of CAE virus antibodies in bulk tank milk. Caseous lymphadenitis (CLA) prevalence was 70 percent according to farmers' clinical observations. Several respiratory diseases also showed high prevalence in clinical observations. Johne's disease was enzootic in parts of southern Norway, and vaccination was made compulsory in these areas to avoid clinical outbreaks. Johne's disease has been notifiable for decades. CAE has been notifiable since 2012.

The Healthier Goats Project started in 2001. The board of TINE SA and Goat Health Services (owned by TINE) are managing it. The aim is to eradicate CAE, CLA and Johne's disease from the Norwegian goat population. The government assigned NKr 97.6 million for a ten-year period.

The project relies on careful organization and detailed regulations.[58] A full-time project leader has been employed. Farmers sign a contract committing them to the project for five years. Local veterinarians and TINE husbandry advisors are contracted to work in accordance with the project protocol.

Methods

1. In herds with CAE prevalence < 10 percent and no indication of CLA or Johne's disease, the test and cull strategy is used to eradicate CAE.

2. Kids are "snatched" from their mothers immediately after birth. They are housed in a clean barn, given cow colostrum, and raised on milk replacer, water, concentrate and hay. Adult goats are slaughtered at the end of lactation. The barn and its surroundings are then cleaned and disinfected.

Photo 3. Snatched kids on pasture in Norway (Source: Lindheim, 2014)

Photo 4. Renovated and cleaned barn in Norway (Source: Lindheim, 2014)

In the snatching procedure, the kids are serologically tested before five weeks of age to detect maternal CAE antibodies. Kids that test positive are slaughtered. Does are re-tested individually before starting their first lactation. Test-positive animals are culled. The healthy goats are then returned to the barn to start their first lactation.

In areas where there have been cases of Johne's disease, pastures are kept free from manure and grazing animals for at least 18 months. The sanitized herds are monitored by clinical observation and antibody detection in serum and bulk tank milk for at least five years.

3. In recent years, it has been possible to buy healthy kids from farmers who sanitized their herds earlier in the project, as an alternative to carrying out the challenging snatching procedure.

58 http://geithelse.tine.no/English

The serological test used is IFN-γ, Idexx ® Elisa Paratuberkulosis Antibody Verification for Johne's disease. The TINE Mastitis Laboratory in Molde, Norway carries out the serological testing and the developing work to interpret enzyme-lined immunosorbent assay (ELISA) tests on bulk tank milk for monitoring.

The financial support for farmers was from NKr 2400 to NKr 2600 per replaced goat, the highest support in areas with compulsory vaccination against Johne's disease. In addition, the project provided free advice, blood sampling and laboratory analysis for five years.

Building knowledge is crucial. A variety of educational efforts for farmers, advisors and veterinarians have been carried out to provide information on the diseases, the project and its methods. Teaching of everyday biosecurity is a high priority.

Photo 5. Building farmers' knowledge of biosecurity in Norway (Source: Lindheim, 2014)

Until 2011, participation in the programme was voluntary. In 2012, TINE lowered the milk price for non-sanitized herds and the Norwegian Food Safety Authority made CAE a notifiable disease, placing restrictions on herds that had not joined the project, which prevents them from taking part in livestock trading and using pastures with small ruminants from other herds.

Results

By the project deadline in 2012, 602 farmers had applied to join: 372 with milk-producing herds and 230 with other herds, mainly of Kashmir, Boer and Mohair goats.

Testing of 137 herds in which eradication by snatching was carried out between 2001 and 2008 detected CAE virus antibodies in 0.8 percent of kids under five weeks of age and 0.9 percent of goats over six months. Test results confirmed that farmers carried out the sanitation process (snatching) and followed the project's procedures accurately. Test-positive animals in sanitized herds were slaughtered.

In 602 sanitized herds, 3 herds were found to be re-infected with CAE, 1 with Johne's disease and 8 with CLA. Re-infected herds are carefully monitored and test-positive animals are slaughtered. In 2012 and 2013, there were no new outbreaks of diseases caused by re-infection in sanitized herds.

The Healthier Goats Project has successfully eradicated CAE, CLA and Johne's disease from 602 Norwegian goat herds. The herds show a significant increase in milk yield and decreased somatic cell counts. Other contagious agents are also removed from herds where the snatching procedure is applied.

Animal welfare is improved by removal of chronic clinical diseases.

Knowledge of disease control and biosecurity among farmers, veterinary practitioners and husbandry advisors has been increased.

By the end of 2014, TINE SA planned to process goat milk only from herds that have proved free of CAE, CLA and Johne's disease.

TABLE 1. HERDS STARTING THE DISEASE ERADICATION PROCEDURE IN NORWAY

	1994–2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Number of herds	5	11	5	15	32	58	48	41	36	68	66	127	90	602

SOMATIC CELL COUNT OF MILK FROM DIFFERENT GOAT BREEDS IN HUNGARY

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Abstract

There is no standard limit value for the somatic cell count (SCC) of raw goat milk in the European Union (EU) despite the need to have milk of very high hygienic quality for the manufacture of fermented milk products and cheeses. Mastitis often results in high SCCs, which – besides the potential risk for humans – cause imperfect milk clotting resulting in slack curd with higher whey releasing properties. Cheese of poor structure and ripening, and bad sensory properties can be the consequence. This study reports on the SCCs of milk samples from five goat breeds in Hungary, measured through two rapid methods and compared with the results from the reference method. The study investigated the applicability and accuracy of the MT-02 02 (Agro Legato Ltd., Hungary) instrument. The authors found that the Whiteside test and the MT-02 instrument were suitable for estimating possible risks and consequences of high SCC in milk before it is processed. The general summarized average milk SCC was 6.64 x 105 ml-1. The greatest difference between the results from MT-02 and the fluoro-optical (reference) method was 5 x 105 ml-1, but this was an isolated extreme value. The r2 of the calculated linear calibration equation was 0.7819; consequently, the MT-02 instrument seems to be appropriate for measuring SCC. The SCCs of the samples did not differ by genotype or season (spring: 5.85 x 105 ml-1; autumn: 6.22 x 105 ml-1).

Key words: SCC, goat milk, rapid test

Introduction

The popularity of milk products – mainly cheeses – made from goat milk with high physiological value, is rising. Mainly soft cheeses are made from goat milk, and they come in a wide variety of shapes, sizes and flavourings. The goat milk is usually processed at small creameries (farmers' creameries) by hand and based on traditional methods, in line with consumers' demand.

The fermentation ability of milk is a very important criterion in cheese making. Both it and the quality of cheese are decisively influenced by the hygienic quality of raw milk (Unger, 2001). The somatic cell count (SCC) reflects these hygienic properties and is strictly controlled through directives giving its limit value in many countries (e.g. 4 x 105 ml-1 for cow milk). However, in most countries there is no regulation of the SCC of raw goat milk. The SCC of milk has been widely investigated by Hungarian researchers, contributing important knowledge on the adverse effects of mastitis, and subclinical mastitis on cheese making (Merényi and Wagner, 1985; Gulyas, 2002; Varga, 2008).

Other researchers have published findings on the close relationship between high SCC in milk and cheese and losses of the constituents in whey (Barbano, Rasmussen and Lynch, 1991; Politis and Ng-Kwai-Hang, 1988; Mitchell, Fedrick and Rogers, 1986). Similar observations published by researchers investigating goat milk proved that rapid determination of the SCC of raw goat milk is essential when making fermented milk products and cheeses (Kukovics et al., 1996; Zeng and Escobar, 1996; Pajor et al., 2009; Chen et al., 2010). Because of the special nature of small-scale milk processing and the lack of regulation, rapid methods are needed to identify goat milk with very high SCCs, which is of poor quality and not suitable for cheese making.

The objective of the research was to monitor the SCCs of raw milk samples from different goat breeds and in different lactation periods. The Whiteside test and the MT-02 instrument (Agro Legato, Budapest, Hungary) were used for SCC determination. The applicability, and precision of the MT-02 instrument for rapid SCC determination was also evaluated, using data from the official fluoro-optical method (Fossomatic instrument) for benchmarking.

Materials and methods

Materials

Samples were collected from two farms on the Great Hungarian Plain. Kidding was scheduled for spring (February–March) on both farms. At farm A, samples were collected on three occasions from ten Alpine and ten Saanen goats in the spring and autumn; and on three occasions from ten Hungarian White goats in July, August and September. At farm B, samples were collected from ten Alpine and ten Alpine x Saanen cross-bred goats in spring and autumn; and only in autumn from ten domestic (native) goats. Goats were hand-milked twice a day. Samples were prepared by mixing the morning and evening milk of individual goats, and were stored at 5 °C until classification. The samples were investigated at the laboratory of the Department of Food Engineering, Faculty of Engineering, University of Szeged, Hungary. Samples used for calibrating the MT-02 instrument were investigated at the Hungarian Dairy Research Institute (HDRI), Budapest, Hungary.

Methods

Whiteside test

The Whiteside test is based on the complex molecule relation between the sodium hydroxide and DNA of somatic cells, and the denaturation phenomenon. Evaluation is based on the ratio of denaturation as determined by the naked eye (Szakály, 1966). Milk is accepted (the result is negative) if there is no visible change in any of its properties, including consistency. The result is positive if visible small particles of approximately 0.5 mm in diameter (similar to semolina) appear in the sample (clumping). In these cases, the SCC is between 2.5 x 105 ml-1 and 1.0 x 106 ml-1. Only samples with values between these two classifications were used in the evaluation.

MT-02 instrument

The principle of this test is very similar to that of the Whiteside test. SCC determination is based on changes in the viscosity of the milk sample.

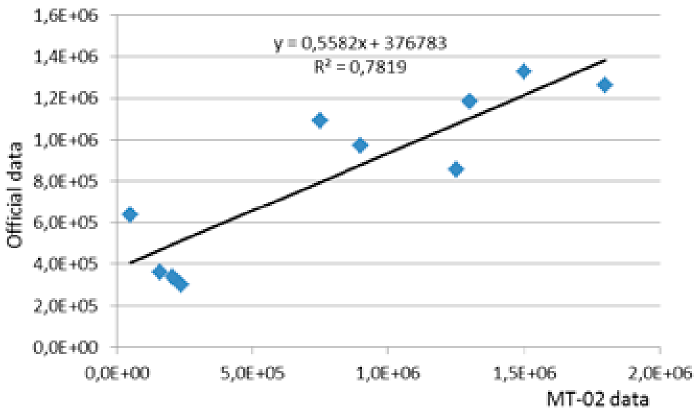
A 10-ml milk sample (at 37 °C) is mixed rapidly with 5 ml of 20-percent reagent (diluted with distilled water) and poured into the instrument's funnel, as measurement has to start immediately. The structure of the instrument is very similar to that of the Höppler viscometer, with the viscometer pipe forced to rotate at an adjusted angle after 20 seconds. The results can be read from the scale built into the pipe. The measuring range is between 10 x 103 and 2 x 106 ml-1. This method was developed for measuring cow milk; HDRI calibrated it for goat milk by using milk samples of known SCC. For this purpose, 20 Saanen goat milk samples were investigated with both the MT-02 instrument and the official fluoro-optical method.

Results and discussion

Estimation of the applicability and calibration of the MT-02 instrument

To evaluate the precision of data from the MT-02 instrument, 20 raw milk samples from Saanen goats were measured with the MT-02 instrument and the fluoro-optical method; the ten suitable samples were then sent to the HDRI laboratory. The resulting data were examined to identify correlations between the two methods. The hypothesis was that if the correlation was sufficiently close, it could be assumed that data from the MT-02 instrument were similarly precise to those from the reference method. Figure 1 shows the correlation between the two sets of data. The acceptable determination coefficient of the trend line made it possible to obtain a more precise evaluation of the SCC of goat milk than from the Whiteside test. This correlation equation was used for SCC determination in the other investigations.

FIGURE 1. CORRELATION BETWEEN OFFICIAL DATA AND DATA FROM THE MT-02 INSTRUMENT



Results from different goat breeds

The average of measured samples determined through MT-02 was 5.69 x 103 ml-1, but the values varied widely. Data from all the samples are summarized in Table 1.

TABLE 1. COMPARISON OF THE ORIGINAL MT-02 DATA AND MODIFIED DATA USING THE CALIBRATED MEASURES (N = 116)

Method	Average (103 ml-1)	Variation (103 ml-1)	CV (%)
Original MT-02 data	569	669	117.5
Data from calibration	665	365	54.9

Thirty percent of all samples did not fit into the measurement range of 1.0 x 103 ml-1 to 2.0 x 106 ml-1, perhaps because the abnormal composition of the milk samples caused extremely low or extremely high viscosity. The reasons for this phenomenon have not been investigated; consequently, it cannot yet be explained. The results show that the SCC values obtained from the MT-02 instrument were underestimates. The calibrated SCC average was only 9.5 x 105 ml-1 higher than the original MT-02 value, but the differences in data pairs from the two methods showed very high variation (5.0 x 104 to 5.0 x 105 ml-1).

The precision of the MT-02 instrument has already been investigated using cow milk, and an average difference of 1.18 x 105 ml-1 was determined from the official data (Anisity, 2008). The calculated difference found in the current study was very close to this data, suggesting that the MT-02 instrument can also be used for measuring the SCC of goat milk, but mainly for SCC values below 1 x 106 ml-1. This limited applicability of the instrument is explained by the resolution of its scale, which is sufficiently fine only for values below 1 x 106 ml-1, and by the use of only a few samples for calibration. The smallest difference between the official and the MT-02 data was in the range of 5.0 x 105 ml-1 to 8.0 x 5 x 105 ml-1. These observations should be taken into consideration when reviewing the study's detailed results.

Alpine goats

Milk samples from Alpine goats were measured in spring and autumn at both farms (Table 2). The first sampling occurred during the suckling period at farm A. Average SCCs at farm B were very similar in the two seasons.

TABLE 2. SCCS OF MILK SAMPLES FROM ALPINE GOATS IN HUNGARY (105 ML-1) (N = 120)

	Farm A		Farm B	
	Autumn	**Spring**	**Autumn**	**Spring**
Min.	3.80	4.90	3.90	2.60
Max.	11.00	14.00	8.60	12.00
Average	**7.28**	**9.25**	**5.90**	**5.78**
Variation	3.50	4.76	2.69	3.02
CV%	48.08	51.46	45.59	52.25
*** WST (%)**	**67.90**	**63.40**	**70.80**	**68.80**

* Data from the Whiteside test, showing the overall ratio (as a percentage) of negative and positive samples. Estimated SCC < 1.0 x 106 ml-1.

One sampling was carried out before the kids were separated from their mothers. The average SCC from this sampling was lower than the overall average for the farm; consequently, the suckling had no adverse effect on the SCC of milk, and did not cause an increase in SCC. Average SCC values at farm A were higher than at farm B, but none of the averages exceeded the 1 x 106 ml-1 threshold. This result differs from that of Varga (2008), who explored SCCs of more than 1 x 106 ml-1 in all investigated samples from refrigerated storage. In the current investigation, 28 percent of the milk samples from Alpine goats reached this limit. This can be viewed as quite a good result given the large number of samples exceeding the measuring limit of the MT-02 instrument.

Other breeds

The average SCCs of samples from Hungarian White goats presented somewhat higher values (Table 3). Mastitis was identified most frequently in this breed. Higher SCC values were typical, and more samples with extremely high SCCs were found at each sampling. Extreme viscosity and stickiness were visible in the samples after adding the reagent to the milk after measuring.

Results from samples from Native, Saanen and Alpine x Saanen cross-bred goats are presented in Table 4. Domestic goats showed wide variation regarding their horns and colours. There were black and white, fawn-coloured, grey, and white goats. Results from domestic (Native) goats showed the highest variation.

TABLE 3. SCCS OF MILK SAMPLES FROM HUNGARIAN WHITE GOATS IN HUNGARY (105 ML-1) (N = 90)

	July	**August**	**September**	**Average**
Min.	3.60	5.80	5.60	5.00
Max.	9.30	11.00	17.00	12.40
Average	**6.93**	**9.05**	**11.2**	**9.06**
Variation	3.54	2.94	5.07	3.85
CV%	51.08	32.49	45.27	42.49
***WST**	**71.80**	**63.20**	**57.40**	**64.10**

* Data from the Whiteside test, showing the overall ratio (as a percentage) of negative and positive samples. Estimated SCC < 1.0 x 106 ml-1.

Evaluating the results shows that they are very similar to the results found by some other authors (Turin et al., 2005; Gulyas, 2002; Stella et al., 2007). However, the average SCCs did not match those published by other authors (Garcia-Hernadez et al., 2007; Delgado-Pertinez et al., 2002). Many authors, including those of the current study, agree that the SCC of goat milk is higher than that of cow milk, even though goats do not suffer from mastitis. This observation also implies that the relationship between the SCC of goat milk and the goat's health status is not as clear as it is in cow milk. The MT-02 instrument seemed to be most precise in the SCC range of 4.0–8.0 x 105 ml-1.

Table 4. SCCs of samples from Native, Saanen and Alpine x Saanen cross-bred goats in Hungary (105 ml-1) (n = 150)

	Domestic		**Saanen**		**Alpine x Saanen**	
	Autumn	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**
Min.	2.10	nd	4.90	1.80	1.60	5.90
Max.	8.20	nd	8.10	8.80	9.20	9.60
Average	**6.87**	**nd**	**6.22**	**5.85**	**5.91**	**8.87**
Variation	3.24	nd	2.95	3.10	3.17	2.63
CV%	47.16	nd	47.43	52.99	53.64	29.65
*** WST**	**48.20**	**nd**	**73.40**	**75.10**	**69.80**	**61.10**

* Data from the Whiteside test, showing the overall ratio (as a percentage) of negative and positive samples. Estimated SCC < 1.0 x 106 ml-1.
nd = no data.

The results of Whiteside tests also proved that the SCCs of goat milk imply good-quality milk that far exceeds cow milk in terms of SCC. This difference can be explained by the different physiologies and milk secretion mechanisms of goats and cows (McDougall and Voermans, 2002). For example, in the United States of America, the action limit (threshold) for the SCC of goat milk is 1 x 106 ml-1. It can be assumed that the negative (-) and positive (+) results that this study obtained from Whiteside tests are representative of 60–70 percent of the goat milk on a typical goat farm. It can be noted that milk samples scoring "++" or "+++" in the Whiteside test classification have limited value: their SCCs exceed 1 x 106 ml-1, they are usually not homogenous, and they often contain sticky and mucous precipitations. Goat milk with such high SCCs is not fit for use in fermented goat milk products. In fact, goat milk with very high SCCs (and serious precipitations) is not fit for making any kind of milk product. Based on their findings, the authors of this study agree with the suggestion made by Zeng (1996): that instruments for measuring SCC in goat milk should be calibrated for goat milk rather than cow milk. The producer of the MT-02 instrument should create a new scale for measuring goat milk samples.

There is also a need to investigate very large numbers of samples in future research to refine the precision of this method, which should be used only for SCCs in the range of 2.0 x 105 ml-1 to 1.5 x 106 ml-1 to ensure reliability.

Conclusions

The demand from industrial consumers and the gastronomy sector for good-quality goat milk, including milk of low SCC, is becoming stronger and stronger. Because the correct threshold for SCC is still fiercely debated, there are no SCC requirements for goat milk in many countries, including in the European Union. In this study, the SCCs of milk samples from different goat breeds showed a wide range, confirming data from the literature. However, the use of goat milk with SCCs above 106 ml-1 for high-quality milk products is not recommended, and can result in products with bad sensory and texture properties. In addition, milk with an SCC of more than 106 ml-1 probably comes from goats that are suffering from subclinical mastitis. Rapid tests can help breeders to produce goat milk with low SCCs and support the process for determining a limit SCC value for high-quality milk. The MT-02 instrument (Agro legato Ltd, Hungary) can be used to evaluate the SCC of goat milk using the correlation equation described in this study. This method is more precise than the Whiteside test, but more data are needed from which to develop a reliable and more precise version of the instrument.

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A REVIEW OF TOXOPLASMA GONDII AND NEOSPORA CANINUM IN GOATS FROM ROMANIA

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Abstract

In Romania, there are limited data regarding toxoplasmosis and neosporosis in goats. This review focuses on the epidemiology of Toxoplasma gondii and Neospora caninum in goats from different areas of Romania based on papers published by the research team over the last seven years. Sero-epidemiological data obtained in 2007–2010 revealed prevalence of 52.8 percent for T. gondii and 2.3 percent for N. caninum antibodies, indicating that toxoplasmosis is more common in goats than neosporosis. Molecular data obtained in 2008–2010 from goat abortion tissues revealed the presence of T. gondii DNA (11.4 percent), but not N. caninum. In 2013, studies performed on goat kids to collect serological and molecular data regarding T. gondii infection indicated that 33.1 percent of goat kids were seropositive, and T. gondii DNA was found in 6.1 percent of the diaphragm tissue. The parasite was isolated from diaphragm tissue and genotype II was identified. N. caninum DNA was found in 1.1 percent of the diaphragm tissue. It should be emphasized that these studies provide new information on the current status of toxoplasmosis and neosporosis in goats from Romania.

Key words: Toxoplasma gondii, Neospora caninum, goats, epidemiology, Romania

Introduction

Apicomplexan parasites have a major impact on human and animal health worldwide. Two of the most important protozoan are Toxoplasma gondii and Neospora caninum. These parasites are closely related and morphologically similar; the major difference is in their biology. Cats and dogs are the definitive hosts for T. gondii and N. caninum respectively, and the host range of N. caninum is more restricted: humans are not intermediate hosts for Neospora, unlike T. gondii (McCann et al., 2008).

Among livestock, N. caninum can cause abortion or neonatal mortality in goats, as can T. gondii (Dubey, 2003; Eleni et al., 2004). The epidemiology of toxoplasmosis and neosporosis in goats has not been fully studied in Romania. There is also limited epidemiological knowledge on parasite diversity regarding T. gondii and N. caninum in goats from Romania. This review presents goat research activities that focus on toxoplasmosis and neosporosis, mainly in central and northwestern Romania, which were published in 2007–2013.

Diverse assays were used to determine the prevalence of toxoplasmosis and neosporosis in goats, and molecular typing was used to identify T. gondii genotypes.

Prevalence of *T. Gondii* in goats

Recent serological surveys from around the world indicate that the prevalence of T. gondii antibodies in goats varies from 18.5 to 66 percent (Bartova and Sedlak, 2012; Diakoua et al., 2013; Lopes et al., 2013).

Iovu et al. (2012) performed an extended sero-epidemiological survey on the prevalence of T. gondii infection in dairy goats from four areas of Romania (Crişana, Maramureş, Transylvania and Muntenia) and found similar prevalence. A total of 735 serum samples were tested for T. gondii antibodies (IgG type). The overall prevalence found was 52.8 percent (388/735). Among areas sampled, the seroprevalence of T. gondii infection varied from 20 to 84 percent: 20 percent (8/40) in Muntenia; 39.2 percent (144/367) in Transylvania; 69.8 percent (194/278) in Crişana; and 84.0 percent (42/50) in Maramureş. Seroprevalence was higher in backyard- raised goats (79.5 percent or 58/73) than in goats raised in herds (49.8 percent or 330/662); and in adults (55.8 percent or 386/692) than in kids (4.7 percent or 2/43). The kids were tested at two months of age, so it is possible that colostrally acquired antibodies were still present. These results indicate that most goats acquire infection post-natally via oocysts. This research is significant because it covered dairy goats and T. gondii can be transmitted to humans via goat milk (Dubey, 2010). It was an extension of a previous study by Titilincu, Mircean and Cozma (2008), which obtained a higher seroprevalence of T. gondii antibodies in adult goats (64.15 percent) and a similar seroprevalence in kids (3.33 percent), from a smaller number of serum samples.

Between 2008 and 2010, samples from 35 aborted goat foetuses (17 samples from foetal fluids, 35 from foetal brains and 35 from foetal hearts) were tested by polymerase chain reaction (PCR). T. gondii DNA was found in four (11.4 percent) of the 35 foetuses, but only in foetal fluid and heart samples (Iovu, 2011). Worldwide, studies on goat abortions have reported similar prevalence. In Italy, the prevalence of T. gondii DNA detected by PCR was 13 percent (3/23) in foetuses and 25 percent (2/8) in placentas (Lopes et al., 2013). In Spain, Moreno et al. (2012) performed foetal histopathology on aborted goat foetuses to detect the presence of T. gondii lesions in the brain, followed by PCR. Lesions of protozoan infection were observed in 15.4 percent (4/26) of the foetuses, but T. gondii DNA was detected in only one foetus, with no lesions. In Argentina, 53 aborted goat samples (25 from foetal fluids, 18 from foetal brains and 10 from placentas) tested by different assays for T. gondii infection revealed the presence of T. gondii by at least one method in 11 (44 percent) of 25 foetuses; T. gondii was identified in 6 (24 percent) of 25 foetuses (Unzaga et al., 2014).

In 2013, a total of 181 paired samples (serum and diaphragm) from naturally infected, backyard-raised kids were tested for T. gondii infection. The kids originated from four areas of Romania: central (Alba, Braşov and Mureş); northwest (Cluj and Satu Mare); west (Hunedoara); and southwest (Vâlcea). The overall prevalence of T. gondii antibodies found in the kids was 33.1 percent (60/181), as detected by enzyme-linked immunosorbent assay (ELISA). The prevalence of T. gondii DNA in diaphragm tissue was 6.1 percent (11/181), as detected by PCR.

Following a bioassay of 32 diaphragms in mice, two isolates were obtained and genotyped by microsatellite analysis. Genotype II was identified (Pastiu et al., 2014). Only a few studies reported the prevalence of T. gondii in kids (Cobadiova et al., 2013; Masala et al., 2007; Misurova et al., 2009).

Prevalence of N. Caninum in goats

Studies show that the seroprevalence of N. caninum antibodies in goats varies from 4.58 to 12 percent (Abo-Shehad and Abu-Halaweh, 2010; Bartova and Sedlak, 2012; Diakoua et al., 2013; Topazio et al., 2014).

Iovu et al. (2012) studied the prevalence of N. caninum antibodies in dairy goats from four areas of Romania (Crişana, Maramureş, Transylvania and Muntenia) and found a lower prevalence. The highest seroprevalence of N. caninum was found in Crişana (8.3 percent or 5/60). All seropositive goats were adults (2.6 percent or 12/469) raised in herds. This was the first report of N. caninum infection in goats from Romania.

Between 2008 and 2010, aborted goat foetuses were also tested for N. caninum DNA by PCR. N. caninum was not detected (Iovu et al., 2010). In Italy, the prevalence of N. caninum DNA in aborted goat foetuses was 8.6 percent (2/23) (Masala et al., 2007). A similar prevalence was obtained in Argentina (Unzaga et al., 2014) and a higher one (11.5 percent) in Spain (Morena et al., 2012).

Șuteu et al. (2013) studied the presence of N. caninum in diaphragm tissue of kids by PCR. The prevalence of N. caninum DNA was 1.1 percent (2/181).

Conclusions

A review of research indicates that goats are exposed to both T. gondii and N. caninum parasites. In Romania, exposure to T. gondii occurs much more often in goats than N. caninum does. Further research is needed regarding toxoplasmosis and neosporosis in goats in Romania.

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PARASITE BURDENS IN CARPATHIAN GOATS IN ROMANIA AND ASSOCIATED HAEMATOLOGICAL AND BIOCHEMICAL PARAMETERS

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Abstract

The investigations discussed in this paper were conducted on a herd of 2 014 Carpathian goats of mixed ages, breeds and sexes in northeast Romania. They aimed to reveal the impact of digestive and pulmonary parasite infections on the animals' haematology, blood biochemistry, growth performance and production. Faecal samples were collected to identify eggs and larvae through qualitative (Willis, Vajda) and quantitative (McMaster, Euzeby) techniques, analysing the intensity and prevalence (E%) of digestive and pulmonary infection. Haematological and biochemical blood parameters were studied. The results were statistically analysed with Student's (t) test, calculating the Pearson correlation index (r) between haematological parameters and parasitic infection. Coproscopical comparative results (obtained from goats in the stall compared with the

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same goats after three weeks of grazing) showed very significant differences ($P \leq 0.001$) for the genus Eimeria and the Trichostrongylidae family, and significant differences ($P \leq 0.01$) for cestodes. Biochemical parameters were generally within the normal range, except calcium, which had decreased values for the whole herd. The index of correlation between pasture infection and the parameters analysed showed strong correlations between haemoglobin and cestodes ($r = 0.917$); erythrocytes and coccidia ($r = 0.882$); erythrocytes and cestodes ($r = 0.777$); and mean corpuscular volume (MCV) and the Trichostrongyilidae family ($r = 0.910$).

Key words: goats, endoparasites, haematology, blood biochemistry

Introduction

Goats show good resistance to some infectious diseases (e.g. tuberculosis, brucellosis), but are known to be sensitive to cold and humidity. In addition, many helminths and protozoan parasites infect goats, and may have immediate (mortality) and long-term impacts (retarded growth, weight loss syndrome, etc.) (Ganter, 2007).

Parasites of the digestive and pulmonary tract may lead to loss in production and are recognized as being responsible for major economic losses (Byers and Kramer, 2010; Boyd, 2005; Cabarett, 1977). Surveillance of herds of goats for parasite infection is necessary to prevent the build-up of parasite populations, which is detrimental to the long-term health and well-being of the goats. It is important to determine whether age and method of husbandry (stall or pasture) influence the parasite burden (Jas et al., 2008).

In rural Romania, under current practices, farmers use pharmaceutical products based on Albendazole or Avermectin to deworm their goats.

The current investigation was conducted to establish the parasite burden of a herd of Carpathian goats kept under a semi-intensive traditional farming system, and to compare various haematological and biochemical parameters of the goats' blood associated with parasite infection.

Materials and methods

Animals

The herd of goats at the end of the stalling period (30 April 2011) included adult dairy goats aged three to seven years (927 females, one male), half-breed young goats from the previous year (632 females), imported Saanen bucks (four males), and kids aged two to three months (400 females, 50 males).

Sample collection

The copro-parasitologicy, haematology and blood biochemistry of the herd were analysed. In April, at the end of stalling, and May, after three weeks of grazing, faecal samples were collected individually by rectal palpation from 5 percent of the herd, according to age, physiological status and sex.

Blood samples were taken from the jugular vein in vacutainer tubes containing edetic acid (EDTA) for complete blood counts and blood smears, and in additive-free vacutainers for biochemical tests. The haematological and biochemical assays were conducted at the same time as the coprological examinations.

Coproscopical analysis

Coproscopic analyses were performed in the Parasitic Diseases Clinic of the Faculty of Veterinary Medicine, using ovoscopic (Willis, McMaster) and larvoscopic (Vajda, Euzeby) methods, both qualitative and quantitative, to analyse the intensity (eggs per gram

[EPG] and larvae per gram [LPG] of faeces and prevalence (percentage of erythrocytes [E%]) of digestive and pulmonary infection.

Haematological and biochemical analysis

Haematological parameters measured with the automatic haematology analyser MS 4.5 (Melet Schloesing Laboratoires, Osny, France) included the numbers of leukocytes (L × 103/µl), erythrocytes (E × 106/µl) and platelets (PLT × 105/µl); the intensity of haemoglobin (Hb g/dl) and haematocrit (Ht%); and the mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC).

Biochemical parameters including alanine aminotransferase (ALT), aspartate aminotransferase (AST), calcium (Ca), magnesium (Mg), urea, creatinine, albumin, globulin and total protein were analysed by photocolorimetric methods using the automatic chemistry analyser Accent 200 (PZ Cormay, SA Lomianki, Poland).

Statistical analysis

The data obtained were statistically analysed using Student's t test and calculating the Pearson correlation index (r) between haematological parameters and parasitic infection.

Results

The coproscopical and haematological results obtained after analysis of the herd at the end of the stalling period were compared with the results obtained after three weeks of grazing for one-year-old goats (Tables 1, 2 and 3), lactating adult goats (Tables 4 and 5) and bucks (Table 6). The biochemical blood results from all categories of goats were also compared (Table 7).

TABLE 1. INTENSITY (EPG, LPG) AND PREVALENCE (E%) OF DIGESTIVE AND PULMONARY INFECTION IN ONE-YEAR-OLD, PREGNANT AND PARTURIENT GOATS, AT THE END OF STALLING, ROMANIA

(n = 10)	Willis, McMaster methods						Vajda, Euzeby methods			
	Eimeria		Cestodes		Trichostrongylidae		Dictyocaulus		Protostrongylus	
Student's t test	EPG	E%	EPG	E%	EPG	E%	Lpg	E%	Lpg	E%
$\bar{x}$	240	90	55	20	5	10	0	0	5.6	40
S	176.06		116.54		15.81		0		10.01	
V%	73.36		211.90		316.22		0		178.80	

$\bar{x}$ = mean value; S = standard deviation; V% = percentage variability.

TABLE 2. INTENSITY (EPG, LPG) AND PREVALENCE (E%) OF DIGESTIVE AND PULMONARY INVASIVE ELEMENTS IN ONE-YEAR-OLD, PREGNANT AND PARTURIENT GOATS, AFTER THREE WEEKS ON PASTURE, ROMANIA

		Willis, McMaster methods						**Vajda, Euzeby methods**			
		Eimeria		**Cestodes**		**Trichostrongylidae**		**Dictyocaulus**		**Protostrongylus**	
		EPG	**E%**	**EPG**	**E%**	**EPG**	**E%**	**LPG**	**E%**	**LPG**	**E%**
Pregnant goats (n = 5)	$\bar{x}$	790		810		80		0		0.8	
	S	937.01	90	1 240.16	90	178.88	10	0	0	1.78	10
	V%	118.61		153.10		223.60		0		223.60	
Parturient goats (n = 5)	$\bar{x}$	160		200		140		0		2.40	
	S	147.47	80	136.93	90	313.05	10	0	0	2.19	80
	V%	92.17		68.46		223.60		0		91.28	
Student's t test		NS (P < 0.05)		NS (P < 0.05)		NS (P < 0.05)		NS (P < 0.05)		NS (P < 0.05)	

$\bar{x}$ = mean value; S = standard deviation; V% = percentage variability.
NS = not significant (P < 0.05).

TABLE 3. HAEMATOLOGICAL PARAMETERS, IN ONE-YEAR-OLD PREGNANT AND PARTURIENT GOATS WITH DIGESTIVE AND PULMONARY INFECTION, AFTER THREE WEEKS ON PASTURE, ROMANIA

(n = 5)	**Haematological parameters**							
	L × 10^3 /µl	**PLT × 10^5 /µl**	**E × 10^6 /µl**	**Hb g/dl**	**Ht %**	**MCV µm3**	**MCH pg**	**MCHC g/dl**
Reference values*	**4–13**	**3–6**	**8–18**	**8–12**	**22–38**	**16–25**	**5–2–8**	**30–36**
4-months pregnant (n = 5)								
$\bar{x}$	12.08	3.01	12.11	9.32	34.32	28.53	7.80	27.34
S	1.05	0.11	1.59	0.76	1.78	3.90	1.49	3.11
V%	8.71	3.96	13.16	8.25	5.23	13.66	19,15	11.39
Correlation index r								
Eimeria	-0.819	-0.558	0.033	-0.383	-0.051	-0.131	-0.260	0.187
Cestodes	0.620	0.218	-0.494	0.917	0.061	-0.401	-0.746	-0.096
Trichostr.	-0.047	-0.047	0.626	0.639	-0.375	-0.703	-0.188	0.639
Protostr.	0.117	0.421	-0.040	-0.668	-0.375	-0.165	-0.311	-0.340
5–12 days post-parturient (n = 5)								
$\bar{x}$	12.02	5.07	9.55	8.2	32.20	33.69	8.62	25.63
S	1.21	1.52	0.73	0.7	2.28	2.53	0.80	3.26
V%	10.12	30.10	7.66	8.62	7.08	7.52	9.37	12.74
Correlation index r								
Eimeria	0.423	0.179	0.882	0.599	0.550	0.468	0.158	0.146
Cestodes	0.187	-0.371	0.777	0.749	0.080	-0.805	0.014	0.503
Trichostr.	-0.468	0.451	-0.834	-0.316	-0.049	0.910	0.404	-0.216
Protostr.	0.165	0.176	-0.465	-0.645	0.080	0.571	-0.281	-0.528

$\bar{x}$ = mean value; S = standard deviation; V% = percentage variability.
* Source: Duncan and Prasse, 2005.

TABLE 4. INTENSITY (EPG, LPG) AND PREVALENCE (E%) OF DIGESTIVE AND PULMONARY INFECTION IN LACTATING ADULT GOATS, AT THE END OF STALLING AND AFTER THREE WEEKS ON PASTURE, ROMANIA

(n = 10)	Willis, McMaster methods						Vajda, Euzeby methods			
	Eimeria		Cestodes		Trichostrongylidae		Dictyocaulus		Protostrongylus	
	EPG	E%	EPG	E%	EPG	E%	LPG	E%	LPG	E%
At end of stalling										
$\bar{x}$	2 050	100	15	30	3 830	100	0	0	56.40	100
S	368.93		24.15		889.50		0		54.86	
V%	17.99		161.01		23.22		0		97.26	
After 3 weeks on pasture										
$\bar{x}$	495	80	375	50	0	0	0	0	28.40	80
S	459.74		1 098.54		0		0		34.69	
V%	92.87		292.94		0		0		122.14	
Student's t test	*** (P ≤ 0.001)		NS (P < 0.05)		*** (P ≤ 0.001)		NS (P < 0.05)		NS (P < 0.05)	

$\bar{x}$ = mean value; S = standard deviation; V% = percentage variability.
*** = very significant (P ≤ 0.001); NS = not significant (P < 0.05).

TABLE 5. HAEMATOLOGICAL PARAMETERS IN LACTATING ADULT CARPATHIAN GOATS AGED THREE TO SEVEN YEARS, NATURALLY INFECTED, AFTER THREE WEEKS ON PASTURE, ROMANIA

(n = 5)	L × 10^3 /µl	PLT × 10^5 /µl	E × 10^6 /µl	Hb g/dl	PVC %	MCV µm3	MCH pg	MCHC g/dl
Ref. value*	**4–13**	**3–6**	**8–18**	**8–12**	**22–38**	**16–25**	**5.2–8**	**30–36**
$\bar{x}$	9.52	5.77	6.43	5.40	16	23.47	7.95	34.63
S	2.71	1.37	1.07	0.42	3.02	3.75	0.46	6.30
V%	28.53	23.82	16.70	7.85	18.88	15.99	5.89	18.19
Correlation index r								
Eimeria	-0.138	-0.582	0.534	0.599	0.100	-0.118	-0.126	0.093
Cestodes	-0.328	-0.735	0.582	0.282	-0.198	-0.425	-0.139	0.319
Trichostrong.	0	0	0	0	0	0	0	0
Protostrong.	-0.767	-0.726	0.616	-0.559	-0.323	-0.477	-0.956	0.141

$\bar{x}$ = mean value; S = standard deviation; V% = percentage variability.
* Source: Duncan and Prasse, 2005.

TABLE 6. INTENSITY (EPG, LPG) AND PREVALENCE (E%) OF DIGESTIVE AND PULMONARY INFECTION IN SAANEN BUCKS, AT THE END OF STALLING AND AFTER THREE WEEKS ON PASTURE, ROMANIA

n = 5	Willis, McMaster methods						Vajda, Euzeby methods			
	Eimeria		Cestodes		Trichostrongylidae		Dictyocaulus		Protostrongylus	
	EPG	E%	EPG	E%	EPG	E%	LPG	E%	LPG	E%
At end of stalling										
$\bar{x}$	110		0		0		0		0	
S	41.83	100	0	0	0	0	0	0	0	0
V%	38.03		0		0		0		0	
After 3 weeks on pasture										
$\bar{x}$	1350		1800		760		0		0	
S	18.33		1890.76	60	1021.88		0		0	
V%	30.98	100	105.04		134.45	30	0	0	0	0
Student's t test	*** ($P \leq 0.001$)		** ($P \leq 0.01$)		NS ($P < 0.05$)		NS ($P < 0.05$)		NS ($P < 0.05$)	

$\bar{x}$ = mean value; S = standard deviation; V% = percentage variability
*** = very significant ($P \leq 0.001$); ** = distinctly significant ($P \leq 0.01$); NS = not significant ($p < 0.05$)

TABLE 7. BIOCHEMICAL BLOOD PARAMETERS OF GOATS WITH DIGESTIVE AND PULMONARY INFECTION, AFTER THREE WEEKS ON PASTURE, ROMANIA

	1-year-old does (pregnant, lactating) (n = 3)			3–7-year-old does (lactating) (n = 3)			2–5-year-old bucks (n = 3)			Ref. val.*
Parameter	$\bar{x}$	S	V%	$\bar{x}$	S	V%	$\bar{x}$	S	V%	
ALT (u/l)	18.46	6.66	36.10	17.53	0.89	5.11	24.30	1.55	6.41	15–52
AST (u/l)	90.24	21.17	23.46	96.30	10.91	11.33	89.89	9.25	10.29	66–230
Ca (mg/dl)	8.07	0.70	8.69	7.27	0.39	5.43	8.53	0.28	3.28	9–11.6
Mg mg/dl	2.29	0.22	9.72	2.40	0.24	9.90	2.40	0.14	6.13	2.1–2.9
Urea (mg/dl)	32.98	12.69	38.48	46.41	8.06	17.37	34.17	6.54	19.16	13–26
Blood urea nitrogen (mg/dl)	15.17	5.83	38.48	21.35	3.70	17.35	15.72	3.01	19.18	
Creatinine (mg/dl)	0.54	0.15	27.56	0.52	0.01	2.90	0.62	0.01	2.43	0.7–1.5
Globulin (g/dl)	3.73	0.26	7.16	4.56	0.26	5.74	4.22	0.34	8.14	3.8–3.9
Albumin (g/dl)	3.32	0.33	9.99	2.97	0.07	2.63	3.41	0.26	7.63	2.3–3.6
Total protein (g/dl)	7.05	0.45	6.48	7.53	0.21	2.87	7.64	0.09	1.27	6.1–7.5

$\bar{x}$ = mean value; S = standard deviation; V% = percentage variability.
*Source: Boyd, 2005.

Discussion

In pregnant and post-partum young goats on pasture, a macrocytic hypochromic anaemia, accentuated in postpartum goats, was recorded. The correlation between changes in the parameters of red blood cells and digestive and pulmonary parasitic infections in these animals was shown by the high correlation indices that were calculated. In young pregnant goats, a correlation index close to 1 (r = 0.917) between cestode infection (EPG mean value of 810) and blood Hb (Hb mean value of 9.32 g/dl) shows the direct implication of cestode parasitism in the development of hypochromic anaemia. The insignificant increases in MCV and MCH without correlation with parasitic infection points to other possible causes of macrocytic anaemia, such as an increase in cellular turnover caused by a deficiency of folate during the gestation period in humans (Hoffbrand and Provan, 2003) and in goats (Azab and Abdel-Maksoud, 1999); or a deficiency of vitamin B12 in goats grazing on pasture with cobalt deficiencies (Haenlein, 1987), as cobalt is an essential element in the structure of vitamin B12 (Byers and Kramer, 2010). The deficiency of B12 folate halts the nucleoprotein synthesis, and maturation is arrested at the prorubricyte and basophile rubricyte stages, causing a release into the bloodstream of large, immature red blood cells. If the deficiency concerns only vitamin B12, the Hb synthesis continues and macrocytic normochromic anaemia develops (Byers and Kramer, 2010). If the organism also suffers spoliation, loss or malabsorption of the minerals that ensure Hb synthesis (iron and copper), as is possible in the digestive parasitism revealed in this study, hypochromia accompanies macrocytosis. The anaemia developed in young post-partum goats is the same macrocytic hypochromic anaemia, which is accentuated in some individuals in this group.

The correlation index between digestive and pulmonary parasitic infection and haematological parameters showed a strong correlation (r = 0.882) between Eimeria infection and the mean number of erythrocytes (9.55 ×106/µl); a strong correlation (r = 0.777) between cestode infection and the mean number of erythrocytes (9.55 ×106/µl); a strong correlation (r = 0.749) between cestode infection and the mean value of haemoglobin concentration (8.2 g/dl); and a close correlation (r = 0.910) between trichostrongylidae infection and MCV (33.69 µm3, above the upper reference limit of 25 µm3). These results suggest a reduced number of erythrocytes, either through digestive haemorrhage induced by species of the genus Eimeria, or through the exhaustion of protein, vitamins and minerals by cestodes of the Anoplocephallidae family, genus Moniezia and Thysaniezia, and by trichostrongylidae identified in the observed subjects.

The close correlation between many parasitic species and changes in red blood cell parameters in primiparous young goats represents an indicator of the association of various physiological and pathological mechanisms for anaemia generation. One of these mechanisms is blood loss through digestive haemorrhage caused by infection with species of Eimeria. Chronic haemorrhage is accompanied by hypochromia caused by the loss of iron that is necessary for haemoglobin synthesis (Byers and Kramer, 2010; Meyer and Harvey, 2004).

In lactating adult goats, after three weeks of grazing, Eimeria and Trichostrongilidae infection was significantly reduced compared with at the end of the stalling period (P ≤ 0.001), but the results show an insignificant increase of cestode infection (P < 0.05). The anaemia produced after three weeks of grazing was accentuated (Hb mean value of 5.40 g/dl), and the type of anaemia was normocytic normochromic (unchanged red blood cell indices). This type of anaemia is characteristic of the depression of erythrogenesis caused by medullar hypoplasia in chronic inflammatory disease, renal and hepatic disorders (erythropoietin insufficiency), neoplasia, endocrine disease and parasitic infection in ruminants (Jain, 1986).

Although the anaemia and hypoproteinaemia pathogenesis in parasitic infections from "blood-sucking" species is clearly specified as a chronic blood loss, with non-blood-sucking species such as Trichostrongylus spp. and Ostertagia spp., the blockage of erythropoiesis has been assigned to various causes: inefficient erythropoiesis; copper deficiency, protein metabolism disorders and selective deficiency of some amino acids; and toxic medullar suppression. Digestive parasitic infection hypoproteinaemia is the regular result of the hypoalbuminaemia caused by gastroenteropathy associated with anorexia and malabsorption (Jain, 1986).

In the current study, the parasitic infection dynamics in primiparous young Carpathian goats and the anaemia type developed after three weeks of grazing differ from those encountered in lactating adult goats and reproduction bucks. "Self-cure" on pasture was not recorded in primiparous young goats, and the anaemia was macrocytic normochromic, resulting from the association between blood loss through digestive haemorrhage and malabsorption of the nutrients that are necessary for erythrocyte proliferation (vitamin B12) and Hb synthesis (amino acids, iron) in bone marrow. In adult goats, as opposed to young ones, after three weeks of grazing, the parasitic infection with Eimeria and Trichostrongilidae decreased ("self-cure") (Cabarett, 1977) and the anaemia developed was normocytic normochromic, caused by low erythropoiesis resulting from protein metabolism disorders (since the end of the stalling period), or possibly by toxic medullar suppression generated by parasitic destruction.

Conclusions

The haematological and biochemical parameters analysed in the herd of goats infected with protozoans of the genus Eimeria, cestodes of the genus Moniezia and Thysaniezia, digestive nematodes from the Trichostrongylidae family and pulmonary nematodes of the Protostrogylus genus, at variable prevalence and intensity, reflect the qualitative and quantitative oscillations of digestive and pulmonary parasitic aggression in the herd, which varied according to age, production category and physiological state. The findings indicate that treatment of goats for parasitic infections on semi-intensive, traditional farms will improve nutrition status and production and that animal management can also affect the parasite burden.

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EFFECT OF ORGANIC VERSUS INORGANIC SELENIUM SUPPLEMENTATION ON THE MILK PRODUCTION TRAITS OF POLISH DAIRY GOATS

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Abstract

The aim of this research was to study the effects of organic versus inorganic selenium (Se) supplementation on the performance of Polish dairy goats. The experiment was conducted during the lactation period on 24 dairy goats in their second to fourth lactations. Goats were divided into two equal-sized, analogous groups. The control group was fed a diet of commercial vitamin-mineral mixture containing inorganic Se (sodium selenite), while the experimental group was fed a diet supplemented with Se in organic binding (Se-yeast at 0.6g/day/goat) without inorganic Se additive. Milk samples were taken each month of lactation. The daily milk yield, its chemical components and somatic cell scores were established.

Supplementation with organic Se had a positive effect on the milk yield, component, and somatic cell count. Despite the higher daily milk yield, the fat, protein, casein, lactose, total solid and non-fat solid contents did not decrease. Moreover, other milk parameters such as acidity and citric and free fatty acid contents also remained unchanged.

Key words: goat, milk production traits, selenium, selenite, Se-yeast

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Introduction

Lack of selenium (Se) in the forage can cause a higher rate of clinical and subclinical mastitis, leading to increased milk somatic cell counts in goats (Erskine, Eberhart and Scholz, 1990). Unfortunately, as the soil in many countries around the world is poor in Se, the amount of this element that animals consume through foraging is insufficient to cover their daily needs (Wasowicz et al., 2003). However, it is possible to supplement animal diets with Se in two forms: mineral (sodium selenite) and organic, in yeast Saccharomyces cerevisiae (Rayman, 2004).

Several studies have been conducted on the influence of Se supplementation on milk yield, composition and somatic cell count (Petrera, Calmari and Bertin, 2009). However, most of these studies relate more to the Se content in milk than to its influence on productivity traits (Stockdale et al., 2011). There is, therefore, limited information on the influence of the form of Se supplement fed to dairy goats on the milk yield and composition. The aim of this research was to study the effects of organic versus inorganic Se supplementation of dairy goats on milk yield, chemical composition and physico-chemical parameters, and on the health status of the animals' mammary glands.

Materials and methods

The experiment was conducted during the lactation period (February to September 2013) on 24 Polish White Improved (PWI) and Polish Fawn Improved (PFI) dairy goats in their second to fourth lactations. The goats were fed according to the system developed by the Institut National de la Recherche agronomique (INRA) of France (Jarrige, 1988). The basic diet consisted of maize silage, wilted grass silage and concentrates, supplemented with a mineral and vitamin mixture. Water was available ad libitum.

The goats were divided into two equal-sized, analogous groups according to their breed and parity. The control group was fed a diet of commercial vitamin-mineral mixture Witamix KW (POLMASS, Poland), containing inorganic Se (sodium selenite), while the experimental group was fed a diet supplemented with Se in organic binding (Se-yeast at 0.6g/day/goat) (Sel-Plex 1000, Altech) without inorganic Se additive. The experiment lasted from three weeks after kidding until day 270 of lactation. Milk samples were taken each month of lactation (eight times).

The milk yield and composition (total protein, casein, fat, lactose, total solid, non-fat solid, free fatty acid, citric acid and urea contents, density and acidity) were estimated using MilkoScanFT2 (FOSS, Denmark). The total somatic cell count was estimated using the IBCM somatic-cell counter (Bentley Instruments, United States of America). The 4-percent fat-corrected milk yield (FCM), value-corrected milk yield (VCM) and energy-corrected milk yield (EBM) and the daily yields of fat, protein, casein, lactose, dry matter and total non-solids were also calculated.

Analysis of variance was conducted using Student's or the Tukey-Kramer test (SAS/STAT) to check the influence of yeast supplementation on milk production traits. Somatic cell count was translated into natural logarithm values as the somatic cell score (SCS). The stage of lactation and parity were also taken into consideration in the statistical model. For the milk components, the regression on daily milk yield was included in the model.

Results

Supplementation with organic Se had a positive effect on the milk yield, components and SCS (Table 1). Both the actual daily milk yield and the yield corrected for the nutrient content of the milk – FCM and VCM – were higher in the group of goats receiving Se-yeast supplementation. No differences in ECM were observed.

Despite the higher daily yield, the fat, protein, casein, lactose, total solid and non-fat solid contents of the milk did not decrease in the experimental group. Because of the higher milk yield in the experimental group, its average daily yields of fat, total protein, total casein, total solids, non-fat solids and lactose were higher compared to that of those found in the control group supplemented with Se in mineral form. The density and freezing point were lower in the milk of goats in the experimental group, and the SCS was 15.8 percent lower. Other milk parameters such as acidity and citric and free fatty acid contents remained unchanged.

Discussion

Other researchers have found an influence of organic Se supplementation on production traits. Silvestre et al. (2007) confirmed the positive influence on milk yield, FCM, concentration of fat and total protein in the milk, but only when Se-yeast (Sel-Plex, Altech) was used. However, the research by Petrera, Calmari and Bertin (2009) found no influence of supplementation with Se-yeast compared with sodium selenite on either the milk yield or the concentration of basic nutrients in the milk. The lack of influence of supplementation with Se-yeast found by these authors may be a result of the relatively short experimental period of only 112 days. In most similar studies carried out to compare the influence of Se in organic or mineral form on milk cows, no differences in daily milk yield or basic nutrient contents were observed, which can also likely be explained by the short experimental period (Petrera, Calmari and Bertin, 2009; Oltramari et al., 2014). The differences in daily milk yield of experimental goats observed in the current research were most likely the result of the Se's influence on the optimization of fermentation processes in the rumen. The beneficial influence of S. cerevisiae or their metabolites on rumen function has already been reported (Kowalik et al., 2012).

The differences in the urea content of milk in the two groups were not statistically confirmed. However, the trend ($p=0.09$) for a decreased concentration of urea in the milk of the experimental group is supported by results obtained by Wang et al. (2009), which show that the addition of Se-yeast to the diet of cows contributes to a decreased concentration of ammonia in the rumen fluid. These authors reported that optimal Se-yeast supplementation had an influence on the optimization of fermentation processes in the rumen, which was positively reflected in increased digestibility of the nutrients and in the quality of the milk.

The results of the current research indicated a decreased SCS in the milk of experimental goats and an increased lactose content. Both phenomena are indicative of a positive impact of Se-yeast on the health status of the animals' mammary glands. The most likely mechanism for the beneficial effect of Se-yeast on reducing the incidence of subclinical mastitis involves the activation of neutrophils and other cells participating in the immune system of the organism.

The freezing point depends on the amount of soluble substances present in the milk, and the content of these substances depends on the physiological condition of the animals and their feeding. Because both groups were fed the same diet except for the Se supplementation, the differences in freezing point may be indicative of the better physiological condition of animals supplemented with the organic Se. The same level of free fatty acids in milk derived from both groups indicates that the form of Se does not influence the intensity of lipolytic processes. Milk owes its acidity to the presence of acidic salts, casein and inorganic and organic acids. Acidity is determined to evaluate the freshness of the milk: fresh milk is acidic and gives values of about 17 Thörner degrees, or 7 °SH (Soxhlet-Henkel) degrees.The results obtained in this study do not differ from earlier results. Another indicator of the freshness of milk is citric acid, whose function is to protect the fats against the harmful effects of oxygen. Fresh cow milk contains

0.16–0.2 percent (160–200 mg/100 cm^3) of citric acid. The content of citric acid found in this research was lower than the average for cow milk. However, it was identical in both groups. In earlier studies, the concentration of citric acid in fresh goat milk was determined at 0.11–0.06 percent, depending on the stage of lactation (Strzałkowska et al., 2010).

Organic Se supplementation improved the productivity traits of dairy goats, the health status of their mammary glands, and their physiological condition.

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TABLE 1. LEAST-SQUARE MEANS AND STANDARD ERRORS (SE) FOR MILK PRODUCTION TRAITS

Trait	Group		SE
	Control	Experimental	
Daily milk yield (kg)	2.35a	2.60b	0.07
FCM (kg)	2.26a	2.50b	0.07
VCM (kg)	2.47a	2.64b	0.08
ECM	2.93	2.90	0.05
SCS	6.32a	5.32b	0.21
Fat (%)	3.78	3.79	0.12
Fat (g)	87.95a	97.15b	3.72
Total protein (%)	3.04	2.91	0.05
Total protein (g)	70.23a	74.14b	2.33
Casein (%)	2.22	2.10	0.05
Casein (g)	51.24a	73.35b	1.88
Lactose (%)	4.62	4.53	0.03
Lactose (g)	109.12a	117.54b	3.56
TS (%)	11.95	11.75	0.16
TS (g)	279.09a	302.23b	8.89
SNF (%)	8.33	8.11	0.07
SNF (g)	194.82a	209.11b	6.24
Urea	151.0	136.0	14.4
Citric acid (%)	0.08	0.08	0.004
FPD	598.7a	586.5b	2.99
FFA (mEq/L)	0.987	0.987	0.05
Density	1025.4a	1024.5b	0.27
Acidity (°Th)	16.9	16.8	0.34

FCM = fat-corrected milk yield; VCM = value-corrected milk yield; EBM = energy-corrected milk yield; SCS = somatic cell score; TS = total solids; SNF =non-fat solids; FPD = freezing point; FFA = free fatty acids; °Th = Thorner degrees (°Th = 2.5 x °SH – Soxhlet-Henkel degrees); density measured at 40ºC.

QUALITY OF MILK AND CHEESE FROM ITALIAN INDIGENOUS GOAT BREEDS FOR SAFEGUARDING BIODIVERSITY AND THE ENVIRONMENT

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Abstract

Indigenous goat breeds from central-southern Italy are known to be less productive in terms of quantity than international breeds such as Saanen or Maltese dairy breeds. These Italian breeds include the Garganica, Jonica and Girgentana breeds, which are reared mostly in semi-extensive systems. Mainly for this reason, they run the risk of extinction in increasingly intensive systems, which seem to emphasize quantity more than quality. The increasing intensification of husbandry is leading to the abandonment of large areas of natural pastures and mountains, which are already showing the first signs of degradation, with the spread of wild undergrowth, the thickening of forests, with risk of fire, etc. In this scenario, indigenous and naturalized goat breeds, which are well integrated into the local natural ecosystem because they evolved in that complex environment, may represent a resource for preventing degradation of the environment, particularly by grazing on natural pastures and in woods. Their potential for having a leading role depends on the quality of their products, such as milk and cheese, which are different from those of international breeds and often have better nutritional char-

acteristics (fatty acid content, volatile organic compounds, oligosaccharides). Italy's indigenous goats therefore provide the potential for dual preservation of animal biodiversity and the environment.

Key words: milk quality, cheese quality, breed, biodiversity, environment

Introduction

In recent decades, the sheep and goat population of Italy has gradually declined to 9 million heads, compared with 13 million in the 1950s. Most of the country's 891 600 goats are reared in central-southern regions (ISTAT, 2012). The Saanen breed, introduced to increase milk production, is also showing a decreasing trend, from 9 795 registered heads in 2008 to the current 6 551 (ASSONAPA, 2013).

A phenomenon of rural abandonment accompanies this decline: permanent grasslands and rangelands no longer used for production and/or grazing of herds are exposed to deterioration and the wild growth of dense vegetation, producing a large amount of dry biomass (which brings a risk of fire) as shepherds and animals – the natural guardians of the woods and pastures –withdraw.

With their grazing behaviour and capacity to utilize feed species that are less attractive to cows and sheep, goats are able to clean the undergrowth and limit the growth of intrusive brush and tree species (Sepe, Claps and Fedele, 2011). Indigenous breeds have developed in the ecosystem in which they live, and are well integrated into the environmental and climate conditions through their feeding and grazing behaviour. Indigenous breeds are often relegated to a marginal role because they are less productive than international ones (such as the Saanen), but recently they have started to become an object of interest, thanks to increasing awareness of the risk of biodiversity loss.

This study examined the assumption that indigenous goat breeds could move from passive conservation to a leading role in the dual preservation of animal biodiversity and the environment, through the quality of their products as an interesting source of income. Goats could become guardians of the environment and producers of quality products through grazing on native pastures. Little literature is available on how breed affects the quality of goat milk and dairy products. This paper presents quality parameters (fatty acid, volatile organic compound, oligosaccharide and sensory properties) for milk, cheese and ricotta cheese collected during studies carried out by the Research Unit of the Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (Muro Lucano, Italy) on Italian goat breeds such as the Girgentana, Garganica, Jonica and Local, and comparisons with the naturalized dairy breeds, Maltese and Red Mediterranean, which are more productive and widespread.

Materials and methods

Fatty acid methyl esters (FAME): Girgentana (GI), Jonica (JO), Maltese (MA) and Red Mediterranean (RM) goats were fed on native pasture and received the same supplementation at milking. In the milk and caciotta cheese processed with the milk, after methylation of the lipid fraction, the FAME content was assessed by gas chromatography (GC Varian 3800, equipped with flame ionization detector). FAME peaks were identified through comparison of retention times with those of known standards (Claps et al., 2007; Di Trana et al., 2009). The health promoting index (HPI) was calculated as the sum of unsaturated fatty acids divided by the sum of lauric, palmitic and fourfold myristic acid (Chen et al., 2004). In a study on the ricotta obtained from GI, Local (LO), MA and RM goats, the FAME were determined by the same method (Pizzillo et al., 2005).

Volatile organic compounds (VOC): The VOC content of milk and caciotta (Claps et al., 2007) obtained from GI, JO, MA and RM goats was assessed by multiple dynamic headspace extraction and gas chromatography mass spectrometry (GC-MS) (Ciccioli et al., 2004).

Oligosaccharides (OS): In milk obtained from GA and MA breeds, after isolation of lipids and proteins, the OS fractions were separated using high-performance anion-exchange chromatography (HPAEC) on a Dionex PA100 column. Data were collected and analysed by Star Chromatography Workstation 6.41 (Varian, Inc. Walnut Creek, California, United States of America), and external standards were used to generate curves for comparison (Claps et al., 2014).

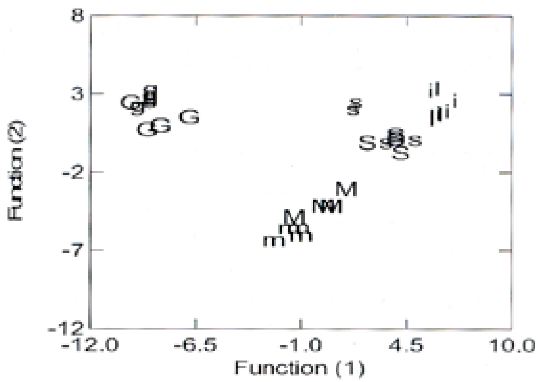
Sensory properties: Caciotta cheese was processed from bulk milk of GI, JO, MA and RM goats (Claps et al., 2007) and ripened for 28 days. In a different study, ricotta cheese was made from whey obtained from the processing of milk from GI, LO, MA and RM breeds (Pizzillo et al., 2005) by heating the whey to 90 °C and collecting the product of the coagulation of whey proteins. The dairy products were then submitted to a panel of ten experts who evaluated their sensory characteristics for colour, odour, aroma, texture and taste.

Results and discussion

The results obtained in all the studies showed that breed significantly affected quality parameters.

FAME: Claps et al., (2007) found significant effects ($P < 0.001$) on all chemical parameters of milk composition (pH, and dry matter, fat, protein and non-coagulating and non-protein nitrogen contents) (data not reported). Moreover, the breed affected the FAME composition of both milk and cheese, particularly for short-chain, medium-chain, saturated and monounsaturated fatty acids, and less so for omega-3 and conjugated linoleic acid (CLA). The discrimination analysis (Figure 1) shows the clear separations among the milk and cheese from each breed.

FIGURE 1. COMPOSITIONS OF MILK AND CHEESE FROM DIFFERENT ITALIAN INDIGENOUS BREEDS OF GOAT, USING TWO CANONICAL FUNCTIONS



Capital letters are for milk contents, lower-case letters for cheese contents.
G = Girgentana; M = Maltese; I = Jonica; S = Red Mediterranean.
Source: Claps et al., 2007.

Similar results were found by Talpur, Bhanger and Memon (2009) on two indigenous goat breeds in Pakistan, confirming the importance of breed on the essential fatty acid composition of milk, under equal feeding conditions.

A study carried out on the same four goat breeds (Di Trana et al., 2009) (Table 1) showed the highest fat content in cheese processed from MA, with 50.74 percent dry matter ($P < 0.001$). The medium-chain fatty acid content varied significantly among breeds ($P < 0.05$), while polyunsaturated fatty acid and omega-3 contents varied very significantly (P

< 0.001), particularly in GI cheese, with 5.31 and 0.74 g/100g of fatty acids, respectively. The HPI value of GI cheese confirmed its health-boosting quality.

A study carried out on fresh ricotta cheese (Pizzillo et al., 2005) from GI, LO, MA and RM milk whey confirmed the features of the GI breed.

TABLE 1. EFFECTS OF BREED ON FATTY ACID CONTENTS OF CACIOTTA CHEESE FROM ITALIAN INDIGENOUS GOAT BREEDS

As % of total methylated fatty acids						
	GI	JO	MA	RM	SEM	P
Saturated	70.69	71.11	70.26	71.28	0.43	ns
Monounsaturated	24.00	24.61	25.18	24.54	0.39	ns
Polyunsaturated	5.31d	4.28abc	4.56b	4.18c	0.08	***
Total omega-3	1.18a	0.94b	1.08a	0.91b	0.03	***
Total omega-6	1.96a	1.91ab	2.00a	1.74b	0.05	**
Total CLA	0.74c	0.64a	0.54b	0.62a	0.01	***
HPI	0.53a	0.41b	0.47b	0.48b	0.026	*

SEM = standard error of mean; ns = not significant. Means with different superscripts (a,b,c) in a row differ significantly for P ≤ 0.05.
* P < 0.05; ** P < 0.01; *** P < 0.001.
Source: Di Trana et al., 2009.

GI ricotta showed the lowest content of saturated fatty acids (P < 0.001) and the highest content of polyunsaturated fatty acids (P < 0.05) because of the higher contents of two essential fatty acids: arachidonic and linoleic acids. Breed significantly affected the contents of the main short-chain fatty acids (Table 2). LO ricotta revealed higher percentages of butyric, capric, lauric, myristic and palmitic acids, directly influencing the flavour of the ricotta.

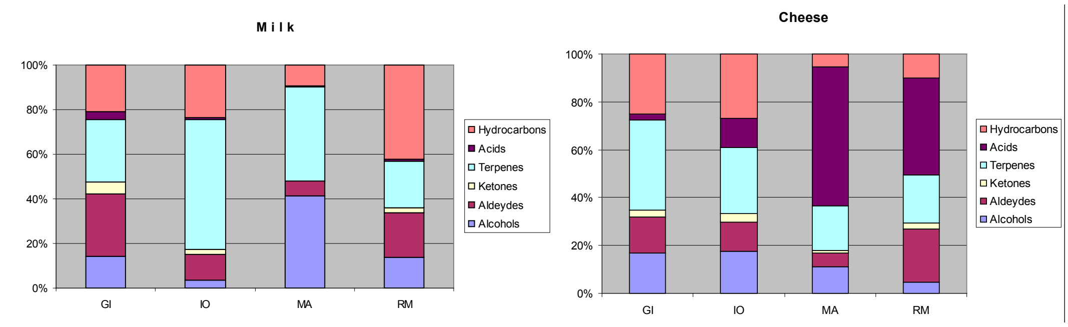
TABLE 2. EFFECTS OF BREED ON FATTY ACID COMPOSITION OF RICOTTA CHEESE FROM ITALIAN INDIGENOUS GOAT BREEDS

As % of total methylated fatty acids						
	GI	MA	R M	LO	S.E.	P
Saturated	65.763c	69.408b	67.240bc	73.364a	0.562	***
Monounsaturated	31.402a	29.022a	31.727a	24.218b	0.580	***
Polyunsaturated	2.835a	1.237b	1.033b	2.417ab	0.303	*
C10:0 – capric acid	7.862c	9.068b	8.379bc	10.700a	0.221	***
C12:0 – lauric acid	4.729b	4.298b	4.099b	6.490a	0.150	***
C14:0 – myristic acid	9.380b	9.995b	9.380b	11.233a	0.151	***
C16:0 – palmitic acid	19.721c	21.944b	21.610b	22.967a	0.194	***
C18:1 – oleic acid	29.724a	28.078a	30.493a	22.728b	0.603	*
C18:2 ϖ6 – linoleic acid	2.195a	0.828b	0.933b	2.072a	0.302	**
C20:4ϖ6 –arachidonic ac.	0.640a	0.408ab	0.100b	0.345ab	0.066	*

SEM = standard error of mean; ns = not significant. Means with different superscripts (a,b,c) in a row differ significantly for P ≤ 0.05.
* P < 0.05; ** P < 0.01; *** P < 0.001.
Source: Pizzillo et al., 2005.

VOC: The results of another study (Claps et al., 2007) showed a breed effect on the VOC profile of milk and cheese, explained in part by the different grazing behaviours among breeds. Both milk and cheese from MA goats revealed the highest contents of terpenes and acids, while those from JO had the highest contents of ketones (Figure 2).

FIGURE 2. VOLATILE ORGANIC COMPOUNDS IN MILK AND CHEESE FROM DIFFERENT ITALIAN INDIGENOUS BREEDS OF GOAT (PERCENTAGES OF TOTAL VOC CONTENTS)

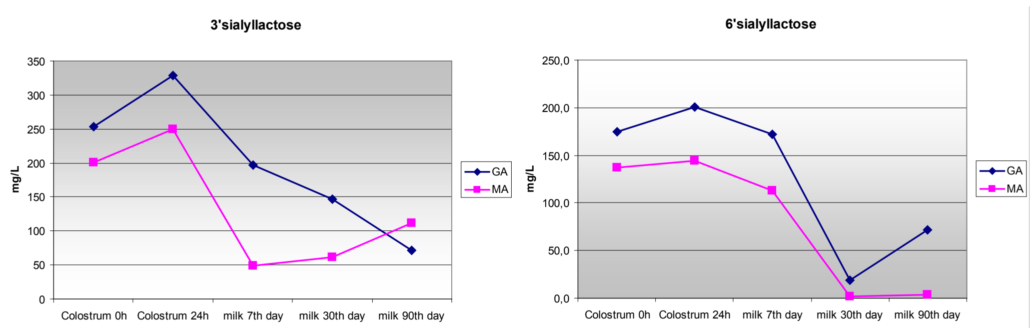


GI = Girgentana; IO = Jonica; MA = Maltese; RM = Red Mediterranean (RM).
Source: Elaborated from Claps et al., 2007.

This result is related mostly to grazing behaviour (Rubino et al., 2005) and highlights the close link between breed and the pasture environment. Indigenous and hardy breeds can take advantage of the grass, shrubs and woody resources of the environment in which they developed differently, and often more efficiently, than international breeds can. A pasture environment is a system that comprises rangeland and grazing animals. Its safeguarding must take grazing animals into consideration.

Oligosaccharides: A study carried out on GA and MA colostrum and milk (Claps et al., 2014) showed that breed affected the OS content of colostrum and milk, as did lactation stage and interaction between the two factors (Figure 3). Just after kidding (0 hours), the colostrum of GA goats showed the highest values for the three OS studied: 3’-syalillactose (3’-SL), 6’-syalillactose (6’-SL) and disialyllactose (DSL). However, the decreasing trends from kidding to day 90 of lactation differed between the two breeds. As the OS profile of goat milk is similar to that of human milk (Urashima et al., 1994), these results suggest that breed may be a factor to take into account in strategies for the utilization of goat milk as a source of OS for human infant formula. In particular, in this study, the indigenous GA breed showed significantly higher values of 3’-SL ($P < 0.01$) and moderately higher values of 6’-SL ($P > 0.05$) than the naturalized MA breed (Figure 3).

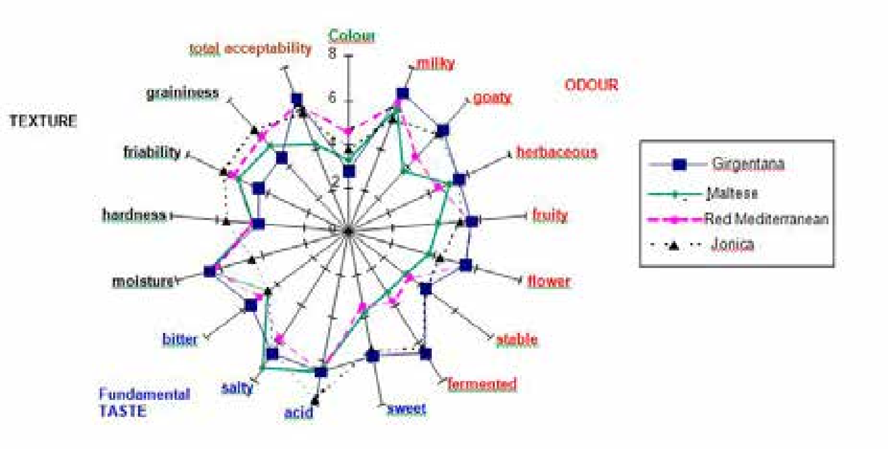
FIGURE 3. TRENDS IN THE 3’-SL AND 6’-SL CONTENTS OF MILK DURING LACTATION FROM HOUR 0 HOUR TO DAY 90 DAYS IN MALTESE AND GARGANICA GOATS IN ITALY (MG/LITRE)



Source: Elaborated from Claps et al., 2014.

Sensory properties: Sensory evaluation is a means of verifying whether physical-chemical differences detected by scientific instruments can be perceived by consumers. The results of two studies (Claps et al., 2007; Pizzillo et al., 2005) confirmed that breed affected all the quality parameters of dairy products. In the study of caciotta cheese (Claps et al., 2007), the panellists found significantly more distinguishable milk flavour in GI cheese than in cheeses from other breeds, as well as lower graininess and friability, probably related to the higher content of fat and the lower level of protein found in GI caciotta (Fig. 4). MA and RM cheeses revealed less pronounced sensory properties than the other breeds, which may be related to the breed, and, indirectly, to the different feeding behaviours in terms of interaction with the environment. The higher total acceptability of GI cheese increased the appreciation of this breed.

FIGURE 4. EFFECTS OF BREED ON SENSORY PROPERTIES OF CACIOTTA CHEESE FROM ITALIAN INDIGENOUS GOAT BREEDS



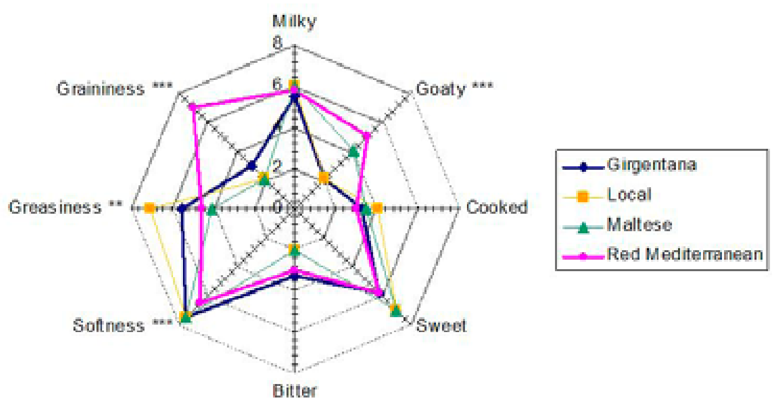
Source: Claps et al., 2007.

In a study of ricotta cheese (Pizzillo et al., 2005), breed affected some texture properties, such as softness, greasiness and graininess (Figure 5). The higher greasiness of ricotta from LO goats can be explained by their higher fat content compared with the other three breeds ($P < 0.01$). The variation of composition (dry matter, fat/protein ratio) from milk, to whey, to ricotta among the four breeds also contributed to the significant differences in sensory attributes. In particular, the greater graininess of RM ricotta might be the result of a lower fat and a higher protein content.

The differences noted at the chemical level were confirmed by the sensory evaluation.

These results suggest that breed should be taken into account when establishing innovative goat milk products or enhancing traditional ones, as there are sensorial differences in the products of different breeds.

FIGURE 5. EFFECTS OF BREED ON THE SENSORY PROPERTIES OF RICOTTA CHEESE FROM ITALIAN INDIGENOUS GOAT BREEDS



Source: Elaborated from Pizzillo et al., 2005.

Conclusions

The results here indicate that the fatty acid profile and VOC of milk and cheese, the oligosaccharide contents of milk and the sensory properties of caciotta and ricotta cheese vary according to the goat breed.

The indigenous and naturalized breeds studied revealed higher values in quality parameters such as monounsaturated and polyunsaturated fatty acids and oligosaccharides, which are beneficial for human nutrition, and higher total acceptability of their cheeses. This result reinforces the assumption that local and naturalized goat breeds can provide high-quality milk products in spite of their lower milk yield. In a policy for protecting and preserving animal biodiversity, which considers the whole pasture–shepherd–animal system, these breeds may contribute to the efficient maintenance of the environments in which they were born or historically introduced and raised.

Acknowledgements

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TESTING OF NANO-SIZED ELEMENTAL SELENIUM-ENRICHED YOGHURT IN HUMAN TRIALS

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Abstract

Selenium is an essential micronutrient with high antioxidant activity although it is toxic in large doses. Elemental selenium is considered the least toxic of all forms of selenium; for supplementation, nano-sized particles of elemental selenium have the same or better bioavailability than selenium salts have.

A nano-sized red elemental selenium sphere has surprisingly good bioavailability and very low toxicity according to the animal and human studies described in this paper. Selenium-enriched yoghurt is, therefore, an ideal method of selenium supplementation in humans.

For the study, 70 healthy human volunteers received 2 decilitres (dl) of selenium-enriched yoghurt every day for two weeks; the yoghurt was produced from cow, goat or sheep milk. A control group received the same yoghurt without selenium. At the start of the experiment and after two weeks, blood samples from the participants were analysed. From the results, proof of an immune-supportive effect of selenium-enriched yoghurt products was obtained, and it was apparent that this type of food product would have positive effects for patients with auto-immune diseases.

The selenium-enriched goat and sheep milk yoghurt was accepted by consumers, who reported being positively surprised by the good organoleptic properties of these products. According to the findings, these products are good potential functional foods, and health claims regarding the immune-supporting effect of selenium could be printed on their labels.

Key words: selenium, yoghurt, elemental selenium, bacteria, functional foods

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Introduction

Selenium is an essential micronutrient for animals and humans. It has high antioxidant activity, although it can be toxic in high doses. Elemental selenium is considered the least toxic of all forms of selenium; for supplementation, nano-sized particles of elemental selenium have the same or better bioavailability than selenium salts have. Bioavailability and toxicity are strongly related to the chemical form of the selenium (Hartikainen, 2005). Organic selenium forms are less toxic but highly bioavailable, so they have significant importance in functional foods, and in food and feed supplements. Nanoparticles of elemental selenium can be prepared by chemical or biotechnological methods. Some bacteria can reduce selenite to elemental selenium and store it in their cells (Eszenyi et al., 2011; Prokisch and Zommara, 2007; 2011).

The selenium particle has a spherical shape and very uniform size, which generally ranges from 100 to 500 nm, depending on the microorganism to which it is applied. Application to the yoghurt bacteria Lactobacillus, Bifidobacterium spp. and Streptococcus thermophilus is especially effective and practical for the production of amorphous, red elemental selenium particles. Modern food supplements and dairy products contain selenium-enriched yoghurt.

The aim of this study was to analyse the effects of selenium from selenium-enriched yoghurt in human trials. Seventy healthy human volunteers each received 2 dl of selenium-enriched yoghurt every day for two weeks; the yoghurt was produced from cow, goat or sheep milk. A control group received the same yoghurt without selenium enrichment. The basic concept was that in a selenium-enriched diet the selenium has effects on the glutathione peroxidase levels of blood, the hormones of the thyroid gland and the consumer's comfort. The study examined the presence in the blood of this important substance from food, how its concentration changes over time after consumption, and whether this change is significant enough to achieve an effect. Before and after the two-week experiment, blood samples from the participants were analysed and the participants responded to a questionnaire. The results provided proof of the immune-supportive effect of selenium-enriched yoghurt products, and showed that this type of food product would have positive effects for patients with auto-immune diseases such as systemic lupus erythematosus. The selenium-enriched goat and sheep milk yoghurt was accepted by consumers, who reported being positively surprised by their good organoleptic properties. According to these findings, selenium-enriched yoghurts have good potential as functional foods, and health claims regarding the immune-supporting effect of selenium could be printed on their labels.

Materials and methods

The study's basic hypothesis was that selenium consumption can improve functioning of the thyroid gland, physical activity and performance, and increase the antioxidant level of blood, as clearly demonstrated in previous studies.

The 70 participants consumed 2 dl of selenium-enriched yoghurt, containing 50µg of selenium, every day for two weeks. Changes in the selenium absorption and antioxidant capacity of serum from their blood were tested. Participants included both men and women with body mass index (BMI) of ≤ 25) and aged between 18 and 70 years; 50 were in the treated and 20 in the control groups. All the participants were informed about the terms and conditions of the experiment and gave their written consent. Prior to starting, they recorded their normal diet for three days to provide information on their nutritional habits. A blood test was carried out on the fourth day to determine the initial levels of selenium, glutathione peroxidase and hormones of the thyroid gland and the antioxidant capacity of the blood. After this blood test, the participants consumed the selenium-enriched yoghurt for the first time. The participants could not follow a vegetarian diet or consume vitamin or other dietary supplements during the experiment, and could not have undergone any drug therapy in the two weeks before the test and on the test day. For the control group, placebo yoghurt that did not contain selenium was used. The yoghurts were ingested under controlled conditions, allowing the examination of selenium absorption and distribution in the human body. The goal was to verify the supposed utilization of selenium in the different treated groups. Yoghurt produced from cow, goat or sheep milk was given the same selenium content. On the fourteenth day, the selenium and glutathione peroxidase levels, the hormones of the thyroid gland and the antioxidant capacity were examined in the blood serum of volunteers.

After the blood testing, the samples were labelled and centrifuged immediately and were kept at room temperature during the testing. The plasma was then divided into four parts for measuring selenium, hormones of the thyroid gland, glutathione peroxidase and antioxidant contents. The samples were taken in labelled Eppendorf tubes and stored at -20 ± 2 ºC until measurement.

The antioxidant level of the plasma was measured using the ferric-reducing ability of plasma (FRAP) method, which is based on the reduction of biologically active substances. This method provides information about the scavenging ability for free radicals. The antioxidants transform iron (III) ions to iron (II) ions in an acidic-buffered medium that forms a coloured complex with tripyridyl triazine (TPTZ). To measure the light absorption on 595 nm, 500 µl of FRAP reagent was mixed with 100 µl of blood serum. This measurement was calibrated to vitamin C standards.

To measure the total selenium content of the blood serum, hydride generation atomic fluorescence spectrometry (HG-AFS) was used. The samples were digested using wet digestion (Kovacs et al., 2000), with 5 ml/cc of nitric acid (HNO_3) (65 m/m percent) added to 1 ml of sample and digested at 60 °C for 60 minutes, then at 120 °C for 240 minutes after adding 3 ml/cc of hydrogen peroxide (H_2O_2) (30 m/m percent). The digested samples were diluted to 15 ml with 3M HCl then filtered. The use of HCl for dilution was necessary for the hydride generation reaction.

The measurements were made using a Millennium Merlin Atomic Fluorescence Spectrometer with the following settings: 15 litre/minute argon carrier gas flow rate, 40 second measurement, 40 second wash time, hundredfold gain. The instrument was calibrated using Charlau standards, and quality control (QC) standards were used every five samples. For the hydride generation reaction, 3M HCl was used as the acid solution and 1.4m/V percent sodium borohydride ($NaBH_4$) in 0.1M sodium hydroxide (NaOH) as the reducing agent.

The glutathione peroxidase and the hormone levels of thyroid glands were measured in the blood serum at the Regional Immunological Laboratory of the Third Department of Internal Medicine, University of Debrecen, Hungary.

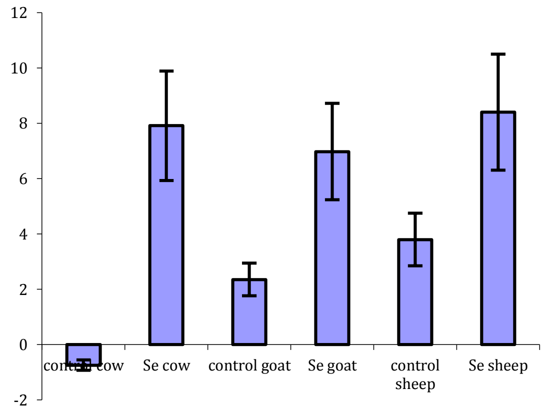
The differences between the initial and the final concentrations were calculated for both the control and the treated groups. The statistical procedure was the rep t-test. If the background variables were inhomogeneous it was necessary to apply variance analysis.

Of the 70 volunteers, 54 were women and 16 men. Each of the two groups – control and treated – had three sub-branches based on whether the yoghurt came from cow, goat or sheep milk. The results were analysed with IBM SPSS 20 software. The distribution of the data was verified by the Kolmogorov-Smirnov test, then the Man-Whitney and Wilcoxon, unpaired and paired t tests. When the p-value of the single-factor variance analysis was less than 0.05, the difference in data was deemed statistically significant.

Results and discussion

Blood selenium levels showed a significant change after the test (Figure 1).

FIGURE 1: SELENIUM ABSORPTION FROM THE DIFFERENT YOGHURTS IN THE CONTROL AND TREATED GROUPS



The largest increase – 8.4 µg/litre – was seen in volunteers receiving the selenium-enriched sheep milk yoghurt. There was also a significant increase in the consumers of selenium-enriched cow milk yoghurt. From these data, it was concluded that the selenium-enriched yoghurts absorbed selenium.

The selenium levels in blood increased collectively, with significant changes. When the results are evaluated as a whole, it can be concluded that selenium plays an important role in the prevention of cardiovascular disease. This conclusion is supported by the fact that alongside the antioxidant effect of selenium, it is known that, as well as the classical risk factors (smoking, hypertension, hypercholesterolaemia), oxygen-free radicals also play a significant role in coronary artery disease and other cardiovascular disease pathogenesis.

An interesting trend could be observed during the quality assessment of the yoghurt: the sensory evaluation of the cow milk yoghurts recorded the highest scores.

In addition to acceptance by the gastrointestinal system, another effect was detected. Before the test, 77 percent of the participants in the selenium-treated group did not report constipation, meaning that 23 percent had some degree of obstipation. After the test, 92 percent reported no problems with constipation, so the test significantly reduced constipation.

During the investigation, the extent to which the participants felt depressed was also assessed. The results show that the selenium-treated group improved more than the control group: before testing, 58 percent of participants in the selenium group experienced lethargy; after the experiment 87 percent reported not experiencing lethargy, which was attributed to the beneficial effects of selenium.

Conclusions

From these aggregated findings, it can be concluded that selenium-enriched yoghurt varieties foster good health and improve well-being. Further longer-term studies of similar products and their marketability are recommended.

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The authors declare no conflict of interest.

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OPTIMIZED TECHNOLOGY, STORAGE CHANGES IN MICROBIAL PARAMETERS AND FUNCTIONALITY OF GOAT MILK PRODUCTS AMENDED WITH INULIN OR OMEGA-3 FATTY ACID CONTAINING OIL

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Abstract

Goat and sheep milk products are known carriers of health promoting compounds of both natural and industrial origin. However, amendments with these compounds may cause changes in the microbiota of the products, influencing the amounts of functional compounds and the potential biological activity of the food. The effects of technological parameters on the application of omega-3 containing oil or inulin were investigated. Analyses were made of changes in six microbial parameters, fatty acid composition and prebiotic activity during 35 days of storage at 5–8 °C in various storage materials. There was no marked difference between goat and sheep milk in the applicability of functional compounds. Among technological parameters, the congelation time increased by 5 percent following the addition of omega-3 containing oil. The insufficient dispergation of oil caused taste failure and greyish discolouring and could be avoided through higher-rev mixing for a shorter time – no more than five minutes. To eliminate microbial contamination of the inulin preparate of 102/g, it was mixed into the basic milk with an industrial mixer before pasteurization for yoghurt processing.

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Although the products were made from the same milk sample, significant differences were found in their hygiene parameters, but the amounts of functional compounds remained almost unchanged. The proliferation of budding yeasts was predominant in the microbiota of goat milk yoghurt and sheep milk smearcase (cottage cheese), but these microbes were not detectable in goat milk smearcase and sheep milk yoghurt. Inulin amendment did not influence the composition of the microbiota. The fatty acid composition of products did not change markedly during storage, but tridecane and docozane acids were not detectable after 35 days.

A snap-closed container gave a microbial count in yoghurt that was six times higher than a welded closure did, but caused no difference in the presence of risk indicator microbes (Escherichia coli, coliforms, Enterococcus faecalis, Staphylococcus aureus).

Both types of milk product proved to be suitable as carriers of functional additives for health promotion, with specialized production and packaging technology parameters.

Introduction

The milk of small ruminants can serve as the basis for the development of functional foods as they ensure good preservation and promote the biological uptake of bioactive compounds. Research has been carried out to develop goat yoghurt containing plant-based materials as components for high added value. Zare et al. (2011) argue that products such as yoghurt provide good opportunities for the development of fibre-enriched foods whose acceptability by consumers is based mainly on their satisfactory textural and sensory quality parameters. Inulin is applied as a soluble fibre for not only sensory but also functional reasons and is among the most frequently used prebiotic compounds in the formulation of functional foods (Buriti et al., 2007). Prebiotics are non-digestible dietary components that reach the colon intact, where they stimulate the proliferation and activity of desirable bacteria in situ (Mattila-Sandholm et al., 2002).

Attempts to incorporate fish oil into the feed of ruminants, to increase the unsaturated fatty acid content of milk, have had poor transformation ratios varying from 0.3 to 1.12 percent (Kitessaa et al., 2001). A recent trend in enhancing the milk lipid profile has prompted the dairy industry to develop new products enriched with omega-3 and omega-6 fatty acids and other components with potentially positive effects on human health. In some new dairy products, milk fat is partly replaced with vegetable fat or a mixture containing fish oil. This increases the levels of omega-3 fatty acids, with consequent benefits to the prevention of cardiovascular disease (Li et al., 2003).

However, the supplements applied may interact with the microbiota of the products, resulting in decreased amounts of functional compounds. Although the addition of fructo-oligo-saccharides alone or combined with inulin was not found to affect significantly the growth and viability of the probiotic strain during manufacturing and the 60-day ripening period, the fatty acid content of the products was significantly increased during ripening (Rodrigues et al., 2012).

The authors of this paper are not aware of any goat or sheep products on the market that have inulin or omega-3 containing oil as functional compounds, and the effects of packaging material and technique on the microbiological status and functionality of these milk products has not been assessed. The aims of this paper were, therefore, to explore the relationships between quantitative changes in the functional compound and microbiota, and the influence of different packaging on the functionality of new food prototypes.

Materials and methods

Product development

Raw sheep or goat milk was pasteurized and used in yoghurt or smearcase processing with regular technologies. This paper discusses and analyses only the goat products. Inulin (Synergie-1 from Orafti) was applied as a prebiotic at 30.0 g/litre for two kinds of congealing. Technology variants where applied for pasteurization time and temperature, incorporation phase of functional compounds, and congelation temperature. In-bottle fermentation was performed with amended milk, while tank fermentation was used for non-amended milk, with inulin mixed into the finished yoghurt before cooling. Omega-3 fatty acid containing fish oil was applied in a similar manner at 0.9 percent. The same ratios of these functional compounds were mixed into the clot for smearcase production. Bottle-fermented yoghurt variants were sealed with snap closures, while the variants produced in-tank were welded closed. Smearcase products were stored in shrink-wrap with vacuum packaging or in a modified atmosphere.

Storage and sampling

Changes in hygiene status and in the content of functional compounds were monitored for 35 days at 5–8 °C – the common temperature for commercial storage. Samples were taken at the start and end of the experiments for chemical analysis, and every five days for microbiological investigations.

Investigations

Chemical analysis was carried out by high-performance lipid chromatography with an evaporative light scattering detector for inulin content, and by gas chromatograpy for fatty acids (decane, dodecane, tridecane, pentadecane, palmitoleic, hexadecane, alfa-linolenic, linolenic, T-9-octadecane, stearic and docozane acids). Microbiological investigations were performed with cultivation on selective media to assess the population size of coliforms Escherichia coli, Enterococcus faecalis, Staphylococcus aureus, moulds and lactic acid bacteria in yoghurt according to the following standards: coliform MSZ 3640-17:1979; E. coli MSZ ISO 16649-2:2005; S. aureus MSZ EN ISO 6888-1:2008; mould and budding yeast MSZ ISO 7954:1999; and E. faecalis MSZ EN ISO 7899-2:2000. Data on the colony forming units were expressed in logarithmic numbers, and analysis of variance was applied for statistical testing of the effects of packaging on the microbial status and amounts of functional compounds.

Results

Many combinations of technology factors were tested for optimization of incorporation of the functional compounds. The changes observed are summarized in Table 1.

TABLE 1. INFLUENCE OF TECHNOLOGY VARIABLES ON THE QUALITY OF PRODUCTS DEVELOPED FROM GOAT MILK

Technology variable	Influence on quality
Milk pasteurization temperature for yoghurt production	90 °C for 180 seconds: soft clot with whey leakage 95 °C for 180 seconds: harder clot without leakage
Yoghurt congelation temperature	36 °C: thick, creamy clot that did not acidify after 8 hours of storage, even without cooling 41 °C: creamy but less viscous product that tends to be over-acidified within 2–3 hours
Yoghurt congelation time	Inulin caused 10% increase in phase length Omega-3 containing fish oil caused 5% increase in phase length The phenomenon can be avoided by raising the temperature by 1–2 °C
Smearcase cutter rev and time	A bad flavour and greyish discolouring appeared at higher revs (3 000/minute) for periods of longer than 5 minutes

Although the products were made from the same milk samples, significant differences appeared in two microbiological parameters, mainly because of differences in packaging. Among the investigated microbes, only budding yeasts showed marked proliferation during the 35 days of cold storage, in both yoghurt and smearcase (Figures 1 and 2). Yeast budding started from 1.75 lg cfu/g and increased continuously to a maximum of 5.49 lg cfu/g in the snap-closed control.

FIGURE 1. YEAST POPULATION SIZES OF GOAT YOGHURT WITH DIFFERENT AMENDMENTS AND TYPES OF PACKAGING

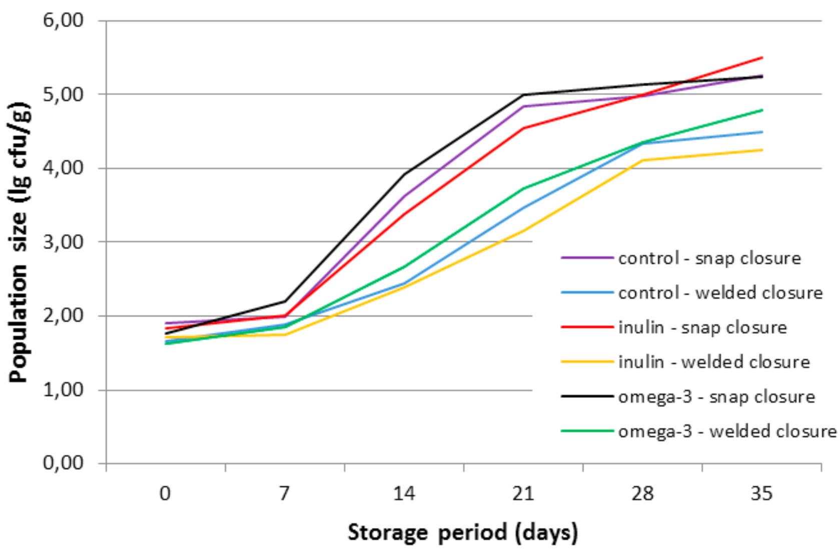
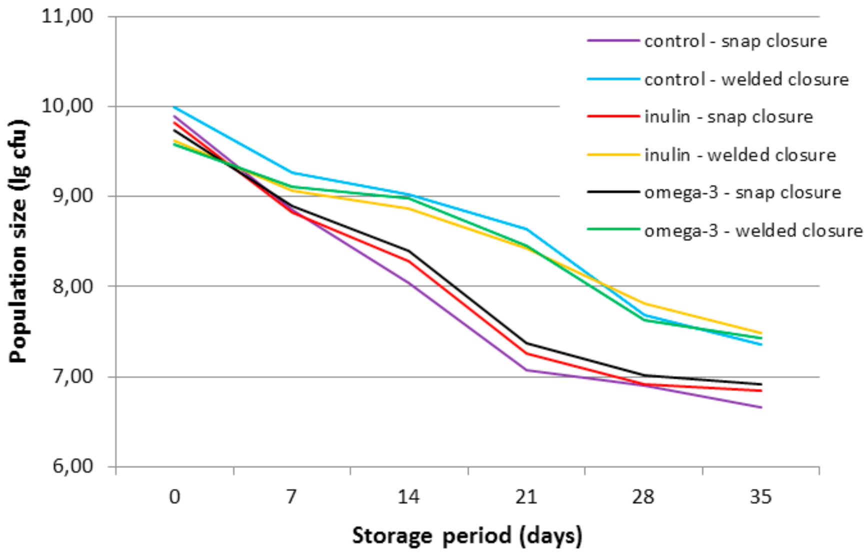


FIGURE 2. LACTIC ACID BACTERIAL COUNTS OF GOAT YOGHURT WITH DIFFERENT AMENDMENTS AND TYPES OF PACKAGING DURING 35 DAYS IN STORAGE AT 4 °C



In the yoghurts, the type of packaging significantly influenced the hygiene status. The snap closure facilitated the proliferation of yeasts, which was pronounced within 14 days, when it was already one order of magnitude greater than the yeast proliferation with welded sealing. In this parameter, no differences were found between sheep and goat milk products, or between the two functional amendments.

The number of lactic acid bacteria in yoghurt decreased significantly after 35 days of storage at 5–8 °C. The size of the decrease was largely affected by the type of packaging. Use of welded closures proved favourable, as it resulted in bacteria numbers that were higher by approximately one order of magnitude. The number of indicator microbes denoting the hygiene status (E. coli, coliforms, E. faecalis, S. aureus) did not change, suggesting that no food safety problems arose in the products examined.

The quantity of inulin as a functional additive did not change in any of the products during processing and storage. The omega-3 content displayed small, insignificant fluctuations. Change in the relative quantity of linoleic acid was the consequence of modification of the amounts of other fatty acids, primarily hexadecanoic acid (Table 2). It should be noted that there was a great difference in this respect between the milks of the two animal species. The ratio of hexadecanoic acid in yoghurt manufactured from sheep milk increased by 9.34–10.29 percent during storage, while in yoghurt manufactured from goat milk the opposite tendency was observed, with a reduction of 8.79–9.87 percent. As a significant change was found only when snap closures were used, the alteration observed may be explained by the proliferation of yeast germs. Further studies might facilitate interpretation of the differences between animal species.

TABLE 2. CHANGES IN THE AMOUNTS OF FATTY ACIDS IN GOAT MILK YOGHURT DURING 30 DAYS OF STORAGE

Fatty acid	Control		Inulin amendment		Fish oil amendment	
	Snap closure	Welded closure	Snap closure	Welded closure	Snap closure	Welded closure
C10:0	-0.37	-0.57	-0.38	-0.58	-0.48	-0.59
C12:0	-0.64	1.14	-0.66	1.18	-0.34	-0.67
C13:0	0	-1.31	-0.19	-1.35	-0.02	2.34
C15:0	3.27	1.3	3.04	1.4	3.49	2.39
C16:1	0.05	1.74	7	1.59	0.06	1.45
C16:0	-8.79*	-3.09	-9.12*	-2.15	-9.87*	-2.21
C18:3 (n-3)	-0.46	-1.9	-0.72	-1.98	-0.78	-2.04
C18:2 (n-6)	5.18	0.88	5.51	0.02	5.67	0
C18:1 trans-9	0	0.87	-2.18	0.09	0	0.04
C18:0	2.92	1.47	0.04	1.23	3.31	-1.27
C22:0	-1.16	-0.53	-2.34	0.55	-1.04	0.56

Values are differences between the percentages of the specific fatty acid in the total fat content measured on days 0 and 30.
* Absolute values of more than 6.89 are treated as significant changes ($P < 0.05$).

Discussion

New functional food prototypes based on goat milk were developed by amending the milk with inulin as a prebiotic or omega-3 fatty acid containing fish oil as an anti-atherosclerotic compound. Changes in microbiological status and amounts of functional additives were followed throughout 35 days in cold storage. It was found that neither inulin nor omega-3 components interacted with the microbial or chemical components of the products, as their amounts remained the same throughout the experiment. Rodrigues et al. (2012) found a similar tendency during synbiotic product development with inulin. They also found that the prebiotic amendments may serve as preserving agents against lipolysis of the conjugated linoleic acid (CLA) in cheese. On the other hand, Raynal-Ljutovac et al. (2008) found that the ratios of C16:0, C18:1trans, C18:3n−3 and total fatty acids were similar in the milk and cheese of sheep and goats, while changes in fatty acid composition during storage could be different in sheep yoghurt. Serafeimidou et al. (2013) found that the CLA content of sheep yoghurt increased during 14 days of storage at 5 °C. The current study did not detect similar changes in fatty acid composition in either sheep or goat milk yoghurt. Weak, insignificant variability was observed in the C18:3n−3 level, but this was caused mainly by a shift in the C16:0 fatty acid level. This phenomenon appeared only when snap-closed bottles were used, when budding yeasts became predominant microorganisms during storage. Budding yeasts are the putative agents contributing to changes in fatty acid composition; Boutrou and Gueguen (2005) found that C18:1 was preferentially liberated by lipase of Geotrichum candidum, which is a frequent spoilage fungus of milk products, while no other microbes proliferated at a similar high rate to yeasts. Further research is needed to clarify the mechanisms through which yeast generates changes in the fatty acid profile of small ruminants' milk products.

This study concludes that goat milk products can serve as carriers of functional additives for health promotion, with specialized production and packaging technology parameters.

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A PROPOSAL FOR A NEW WELFARE ASSESSMENT PROTOCOL FOR DAIRY GOATS

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Animal welfare

Animal welfare is currently considered an essential trait in defining the quality of animal-derived products. Society's demand for assurance systems that certify health, food safety and the way in which animals are treated has increased tremendously over recent decades. This is particularly evident in Europe, where consumers are very demanding. In response to this call, assessment of animal welfare at the farm level is currently a substantial issue in the field of animal husbandry. Various protocols for on-farm welfare assessment have been developed and are currently a major issue for the European Union (EU) animal welfare strategy.

Animal welfare assessment became a concern when very intensive production systems were developed in the industrial world soon after the Second World War. During the 1960s, the Brambell Report suggested the Five Freedoms as a comprehensive and easy way to measure welfare:

- Freedom from hunger and thirst – through ready access to freshwater and an adequate diet that maintains full health and vigour.
- Freedom from discomfort – through provision of an appropriate environment, including shelter and a comfortable resting area.
- Freedom from pain, injury or disease – through prevention or rapid diagnosis and treatment of health problems.
- Freedom to express normal behaviour – through provision of sufficient space, proper facilities and company of the animal's own kind.
- Freedom from fear and distress – through ensuring conditions and treatment that avoid mental suffering.

In 2008, the EU Welfare Quality project redefined these guidelines, converting them

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into four Welfare Principles, linked to 12 criteria. The four principles were identified as good feeding, good housing, good health and appropriate behaviour. Each principle highlights a critical animal need and is divided into different criteria that represent specific areas of physical or mental welfare (Table 1). Criteria are independent of each other and form a minimal but exhaustive list.

TABLE 1. THE PRINCIPLES AND CRITERIA FOR ANIMAL-BASED WELFARE ASSESSMENT PROTOCOLS

Principle	Criteria
Good feeding	Absence of prolonged hunger Absence of prolonged thirst
Good housing	Comfort for resting Thermal comfort Ease of movement
Good health	Absence of injury Absence of disease Absence of pain induced by management procedures
Appropriate behaviour	Expression of social behaviours Expression of other behaviours Good human–animal relationship Positive emotional state

Source: EU, Welfare Quality.

Need for welfare requirements

Welfare assessment requires a multidimensional approach and a welfare assessment protocol should include indicators that are valid (measure what they are meant to measure), reliable (produce the same results regardless of the observer or the occasion) and feasible (can be measured at the farm level with reasonable cost and time requirements). Good welfare assessment schemes should include diverse indicators to provide an accurate picture of the reality, and one indicator should not be used to compensate for the lack of another.

There are three broad categories of indicator that can be used to assess animal welfare at the farm level: resource-based, management-based and animal-based. The first two types are relatively straightforward and easy to collect, but do not say much about the actual quality of life of the animals. Recently, the European Union (EU) has emphasized the need for welfare schemes that focus on animal-based rather than resource-based or management-based indicators. Animal-based indicators seem more suitable for measuring the actual welfare state of the animals, and represent a considerable change in perspective, from a scheme that measures mainly environmental aspects and that may show high variation among countries resulting from different housing and management conditions, towards a scheme that measures the way in which the animals themselves respond to the environment. The EU's Welfare Quality project studied some of these animal-based indicators in three species (bovine, swine and poultry), but very little has been done or published about the welfare of small ruminants, especially goats.

The Animal Welfare Indicators project (AWIN) was launched in 2011 under the title "Development, integration and dissemination of animal-based welfare indicators, including pain, in commercially important husbandry species, with special emphasis on small ruminants, Equidae and turkeys". It is financed by the EU VII Framework Programme and was due to present its final results in May 2015.

AWIN work is divided into four work packages (WPs):

- WP1 aims to develop animal welfare assessment protocols, including pain assessment protocols, for sheep, goats, horses, donkeys and turkeys.
- WP2 studies the impacts of selected diseases and procedures on animal welfare, particularly through the pain they cause.
- WP3 addresses how different prenatal social environments, social dynamics and prenatal handling methods may affect the development and welfare of the offspring of sheep, goats and horses.
- WP4 is preparing a global hub for research and education in animal welfare, which will integrate past, present and future research and teaching materials.

The welfare protocol for goats

AWIN developed a protocol for intensively kept dairy goats for three main reasons: intensive dairy goat keeping is a growing system in Europe; there are severe welfare problems to be addressed in this system; and consumers are particularly concerned about the quality of life of animals kept in very close confinement.

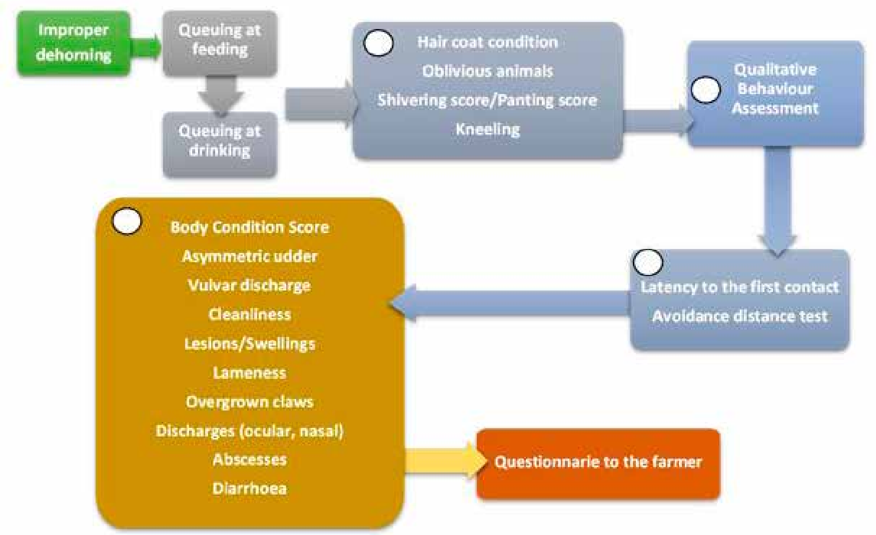
Development of the protocol started with selection of potential animal-based indicators from the scientific literature. This review was published by Battini et al. in 2014. From this broad literature research, approximately 50 indicators were selected and discussed with experts from different countries, to align with the four principles and 12 criteria presented in Table 1. This phase was followed by studies in Portugal (University of Lisbon) and Italy (University of Milan) to assess the validity, reliability and feasibility of each of the most promising indicators. The result was a prototype that includes 24 animal-based indicators (Table 2), which can be assessed relatively quickly without disturbing the animals too much or disrupting routine farm work. Some of these indicators are related to only one criterion, while others convey information on several welfare issues. For example, the body condition score (BCS) may provide information on disease prevalence (e.g. paratuberculosis or caprine arthritis encephalitis virus [CAEV]), long-term food restriction, unbalanced diet, parasitism, etc.

When the assessors visit a farm, a short but comprehensive questionnaire is proposed to the farm owner or stockperson to facilitate analysis of resource- and management-based data that may prove essential to the overall welfare assessment. It may also help to explain some results from the assessment of animal-based indicators. This prototype has now been tested in more than 60 intensive dairy farms in Portugal and Italy. An order in which to assess the indicators was established to guarantee smooth data collection (Figure 1), reducing disturbance to both animals and farmers, and especially to ensure that behavioural results are not affected by handling or other sources of disturbance. For this reason, all the indicators collected before human–animal relationship tests (latency to first contact and avoidance distance test in stage 5) are recorded from outside the pen, with minimal disturbance to the animals.

TABLE 2. ANIMAL-BASED INDICATORS AND CORRESPONDING WELFARE CRITERIA INCLUDED IN THE PROTOTYPE FOR WELFARE ASSESSMENT OF DAIRY GOATS

Criterion	Indicator
Absence of prolonged hunger	BCS, queuing at the feeding barrier, condition of hair/coat
Absence of prolonged thirst	Queuing at the drinker
Comfort for resting	Coat cleanliness
Thermal comfort	Panting and shivering score
Ease of movement	Kneeling (at the trough)
Absence of injuries	Lameness, claw overgrowth, lesions and swellings, kneeling (in the pen)
Absence of disease	BCS, discharges (nasal, vulvar and ocular), diarrhoea, hair/coat condition, abscesses
Absence of pain induced by management procedures	Improper disbudding and dehorning
Expression of social behaviours	Presence of apathetic animals, queuing at the feed barrier and drinker
Expression of other behaviours	
Good human–animal relationships	Avoidance distance test, latency to first contact
Positive emotional state	Qualitative behaviour assessment

FIGURE 1. FLOW CHART INDICATING THE ORDER FOR ASSESSING INDICATORS ON THE FARM



Description of all the indicators selected is not possible in this short paper, but how and where to measure qualitative behaviour, the BCS and lameness are presented as examples, and some of the potential constraints and problems encountered are discussed.

The qualitative behaviour assessment (QBA) is a whole-animal approach, integrating perceived details of the animals' expressive demeanour using terms such as tense, anxious or relaxed. It was first developed by Dr Françoise Wemelsfelder; since then, it has been used in several farm species and was included in the Welfare Quality protocols. The University of Milan team conducted a study to validate several descriptors for inclusion in the final goat welfare assessment protocol. QBA is assessed from outside the pen by observing the group as a whole for 15 minutes and scoring the intensity of descriptors such as agitated, stressed, fearful and calm in a visual analogue scale.

The BCS estimates the nutrition status of an animal and is traditionally assessed by palpation of body fat reserves. As palpation was considered infeasible in an on-farm welfare assessment protocol, and as the main purpose was to determine very thin and very fat animals, the Portuguese team developed a pictorial body image scale for quick assessment of BCS in dairy goats. Each goat should be assessed from behind in a standing position, ensuring that there is a clear view of the rump region. Several measures have to be estimated (Photo 1): the transversal distance halfway between the ilium and ischial tuberosities (1 in Photo 1); the longitudinal distance between ilium and ischial tuberosities (2); the concavity/convexity area on either side of the rump (3); and the concavity/convexity perimeter on either side of the rump (4). This has been found to be a reliable way of quickly calculating the BCS of goats in intensive dairy farm conditions.

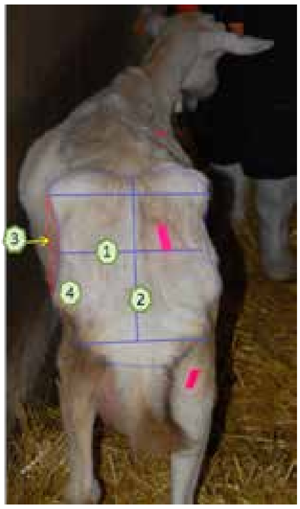


Photo 1. The lines and measurements needed for immediate calculation of BCS in dairy goats. (Source: AWIN-Animal Welfare Indicators, 2014)

Lameness negatively affects dairy goats' productivity by reducing milk yield and fertility and contributing to pregnancy toxaemia. Lameness is regarded as one of the most serious welfare problems in dairy ruminants. A very comprehensive lameness scoring system was found to be time-consuming and unfeasible or unreliable. Instead, a two-level scale was adopted allowing the identification of non-lame, slightly or moderately lame, and severely lame animals. This last grade provides an overall picture of the situation on each farm as it correlates closely with the prevalence of moderately lame animals. Previous studies in dairy cows have identified abnormal gait, head nodding and arched back as being the most valuable to observers assessing lameness. In goats, the studies by Lisbon and Milan universities found the same result. To assess severe lameness, the observer should walk around the pen, viewing all the animals in terms of these three attributes. All the goats lying down should be forced to stand and encouraged to walk.

Each of the indicators selected has its own collection protocol, which will be available in a series of learning tools that are currently being developed under WP4, in collaboration with the WP1 teams in Portugal and Italy. In this learning material, where and how to collect information is presented together with exercises for verifying the expertise gained. In this way, transparency is guaranteed and the training of new assessors becomes relatively easy. Additionally, farmers can use the material to self-evaluate their own animals and farms.

The final welfare assessment protocol, now available at http://www.animal-welfare-indicators.net/site/flash/pdf/AWINProtocolGoats.pdf aims to fulfil two main objectives:

- To allow certification of the welfare level of dairy goats in intensive farms, quickly and reliably. If the results from the first step in the protocol show important deficiencies, a deeper evaluation may be necessary as a second step.
- To provide a tool that farmers, veterinarians and other technicians can use to monitor dairy goat herds, allowing for the early detection of husbandry or health problems. For example, underproduction may be due to subclinical diseases, which may be highlighted by applying this type of assessment protocol.

Readers interested in obtaining more information should keep an eye on the project site[73] and on the Animal Welfare Science Hub, where much more information and the learning materials will be available.

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LARGE-SCALE TECHNICAL AND ECONOMIC VALIDATION OF THE FLOCK REPROD AI PROTOCOLS

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** "Hormone-free non-seasonal or seasonal goat reproduction for a sustainable European goat-milk market" project, funded by the European Union (FP7, FLOCK-REPROD Grant Agreement 243520)*

74 ARAL – Italy
75 VEF – Croatia
76 Capgènes – France
77 Genoé – France
78 INRA – France
79 AUTH –Greece
80 UNISS – Italy
81 Ancras – Portugal
82 INIAV – Portugal
83 OVIDIUS – Romania
84 CAPRIROM – Romania
85 INIA – Spain
86 IMIDA – Spain
87 ACRIMUR – Spain

Overview of the project

FLOCK-REPROD is a European project that was supported by the Seventh Framework Programme (Capacities, Research for SME Associations), in which small and medium-sized enterprises (SMEs) outsourced research and development work to research and technology development (RTD) partners to solve problems and increase scientific knowledge about the technical solutions developed in the project.

The project consortium involved 15 partners from seven European Union (EU) Member States (Croatia, France, Greece, Italy, Portugal, Romania and Spain). The partners comprised seven research entities (research institutes or universities) leading research for the benefit of eight SMEs and SME associations (goat breeders' associations, one milk factory, breeders' associations and semen production centres). The associations represented more than 1 500 breeders, and were led by CAPGENES (France).

The project aimed to develop innovative solutions for ensuring the supply of hormone-free goat milk and related products (such as cheese and butter) throughout the year. FLOCK-REPROD proposed solutions based on technologies that require no hormonal treatment and allow both control of the seasonality of goat reproduction and application of artificial insemination (AI). Through these solutions, FLOCK-REPROD will help goat breeders produce more milk (including organic goat milk), and provide an alternative way of meeting EU legal requirements that restrict the use of hormonal treatments (such as the progestogens that are currently used by dairy goat breeders to control reproductive cycles and enable AI).

The project has focused on the 11 main goat breeds used in the European milk industry, including highly seasonal northern breeds (Alpine, Saanen, Carpathian, Banat White) and moderately seasonal southern ones (Damascus, Scopelos, Capra prisca, Murciano-Granadina, Malagueña, Serrana, Sarda). This approach ensured that the project's findings are applicable across the EU.

Project objectives and work plan

The main objectives of the project were to:

1) master use of the male effect combined with light treatments as a tool to induce synchronous ovulations in dairy goats for optimal efficiency of AI in and out of the natural reproduction season;

2) develop protocols/tools (for the male effect, light treatment and AI) that are adapted to both small and large goat farms, different EU geographical locations, technical constraints and different goat breeds;

3) demonstrate the feasibility of these techniques with end users from technical, operational, environmental and economic perspectives;

4) produce a training module and a user's guide to ensure uptake of the FLOCK-REPROD technology by all EU breeders;

5) validate a business model for facilitating the exploitation of FLOCK-REPROD techniques at the European level via a European technical group and the FLOCK-REPROD trademark.

To achieve these goals, the project work plan was structured into six work packages (WPs).

In the "Research and development" work packages (WP1–WP3), the RTD partners carried out experiments to test and improve the different techniques proposed. SMEs were also involved in parts of this experimental work. The main outcome from these three WPs was a series of proposed protocols based on use of the male effect and light treatment to obtain a high level of synchronization of ovulations and to enable optimal AI procedures during the breeding and non-breeding seasons. The objectives of each work packages were as follows:

- WP1 defined an efficient male effect protocol.
- WP2 developed innovative light treatments to improve efficiency of the male effect in both the breeding and non-breeding seasons.
- WP3 developed protocols for progestogen-free AI (PG1, PG2 and HF) using the male effect and photoperiodic protocols to induce and synchronize ovulations.

The "Demonstration" work package (WP4) involved all the SMEs and their associations in testing the final protocols developed in WP1–WP3 in field conditions, so that they could be optimized and validated prior to the dissemination and exploitation of project results in WP5.

The "Technology transfer and outreach" work package (WP5) was dedicated to setting up the processes for exploiting the project's results (establishing a trademark, licences, a European technical group, etc.) and developing a user's guide and training course (DVD) for dissemination and transfer of the FLOCK-REPROD protocols to end users outside the project.

Finally, WP6 was dedicated to management activities.

WP4 results

During demonstration activities (WP4), a large-scale exercise for the technical and economic validation of the final AI protocols without hormones – defined during WP1–WP3 – was carried out by all the SMEs and SME associations in collaboration with research institutions. WP4 activities involved a total of 3 819 goats of nine breeds, on 56 farms in seven countries (Croatia, France, Greece, Italy, Portugal, Romania and Spain).

On each farm, fertility rates were compared between a group of goats treated with the commercial hormonal treatment (control group HT) and a groups treated with the new AI protocols (PG1, PG2 or HF). The starting date of each reproduction protocol depended on the seasonality of the breed/country and the physiological status of the animals at the time of planned reproduction. Some protocols were implemented during the sexual season, when about 100 percent of the female goats are cycling; others were implemented during the seasonal anestrus, when only 0–10 percent of the females are cycling.

The PG2 protocol can be used during the breeding season, when 90–100 percent of females are cycling, without a previous photoperiodic treatment. This protocol is based on the male effect and two injections of PGF2α, and involves a single AI performed 60 hours after the second injection.

During demonstration of the PG2 and HT protocols in field conditions, pregnancy rates varied from 30 to 84 percent depending mainly on the farm. This variability in kidding rate was observed with both PG2 (46–76 percent) and HT protocols (55–84 percent). Using the PG2 protocol, the kidding rate was satisfactory (averaging 58 percent), but about 8 percent lower than under the HT protocol (averaging 66 percent).

The PG1 and HF protocols can be used during the non-breeding season, when 0–10 percent of females are cycling, if combined with a classical photoperiodic treatment (except in the Murciano-Granadina breed, for which light treatment is not necessary). These protocols can also be applied during the breeding season (when 90–100 percent of females are cycling), provided that the animals have previously received the new photoperiodic treatment based on the continuous alternation of three months of long days and three months of short days, so that fewer than 10 percent of females are cycling at the time of the male effect.

The PG1 protocol is based on the male effect and a single injection of PGF2α. The protocol involves a single AI 70 hours after the PG injection. During implementation of the AI protocols in field conditions, acceptable pregnancy rates (averaging 45 percent) were obtained with the PG1 protocol, although these rates were 10–30 percent lower than those obtained with the HT protocol. Pregnancy rates were also highly variable among farms, under both the PG1 (9–92 percent) and the HT protocols (33–93 percent).

The HF protocol is based on the male effect and a single AI at a fixed time based on the occurrence of oestrus. During demonstration in field conditions, two AIs were compared (one 12 hours and one 24 hours after "positive detection day"). On average, positive detection occurred 7.8 days after males were introduced (ranging from 7.5 to 8.5 days). The threshold of "50 percent marked goats" within eight full days was not achieved on 8 of the 21 farms involved in the demonstration phase. The pregnancy rate obtained with AI 24 hours after positive detection was higher than that obtained with AI at 12 hours (57 versus 45 percent). In the HF protocol with a single AI 24 hours after positive detection (HF-24h), about 50 percent of females exposed to the males were inseminated, with a mean pregnancy rate of 58 percent, similar to that obtained in the HT protocol (60 percent). As observed with the other AI protocols, the pregnancy rate varied among farms under both the HF-24h (17–93 percent) and the HT protocols (31–93 percent).

TABLE 1. PREGNANCY RATES* AFTER AI DURING THE THREE PHASES OF DEMONSTRATION ACTIVITIES (PERCENTAGES)

Protocol	n	Demo 1	Demo 2	Demo 3
HT	1202	66	63	60
PG2	212	58	--	--
PG1	721	--	45	--
HF-24h	145	--	--	58

n = number of inseminated goats.
* Pregnancy diagnostic by echography 45 days after AI.

Regarding cost/benefit analysis, the new protocols (PG2, PG1 and HF) were generally less efficient in terms of working time and input costs than the classical hormonal treatment (HT). PG1 was the most time-consuming protocol, followed by HF and PG2. HF appeared to be the most expensive during both the breeding and the non-breeding seasons; PG2 was cheaper than PG1 during the breeding season. The increased workload and higher costs generated by the new AI protocols compared with the HT protocol were mainly because of the number of supplementary bucks required to carry out the male effect (with higher feed costs and time-consuming buck handling).

Although total input costs were higher under the PG1 and PG2 than the HT protocols, fixed costs associated with insemination were lower, mainly because of savings on the hormone costs (pregnant mates' serum gonadotropin [PMSG] and sponges). In contrast, in most countries, fixed costs under the HF protocol remained higher than those under the HT protocol, because of the need to perform the male effect on twice as many goats as were meant to be inseminated.

Conclusions

The new progestogen-free PG1, PG2 and HF protocols are now available to farmers. However, these protocols can still be improved. The main problem linked to their implementation was the high variability of fertility results among farms. This variability could be partly explained by differences in the response to the male effect, the use of frozen-thawed or cooled semen, or problems linked to oestrus detection. The PG1 and HF protocols are both based on the induction of ovulation by male effect. It is thus essential to take into account the seasonality of goats (definition of the breeding and non-breeding seasons) and to follow all recommendations on the implementation of photoperiodic treatments and the male effect, to optimize the ovulatory response to male exposure, reduce its variability and obtain satisfactory fertility results after AI. Further studies will be required to control the variability in responses to the male effect and to develop new methods for simplifying the detection of oestrus and increasing its efficacy.

The new protocols (PG2, PG1 and HF) generally perform less well in terms of working time and costs of inputs than the control protocol (HT).

In terms of number of working days required, the HT protocol (with four days) is favoured, while the new protocols require ten days for HF, 12 for PG2 and 20 for PG1.

The labour time with respect to the number of goats treated (large, medium or small group) also favours the HT protocol, followed by PG2, HF and lastly PG1 (the most time-consuming).

Fixed costs associated with insemination are lower with the PG2 and PG1 than the HT protocol, mainly because of savings on hormone costs (PMSG and sponges). On the contrary, fixed costs under the HF protocol are higher than under HT in most countries (Croatia, France, Greece, Romania and Spain), because of the need to perform the male effect on twice as many goats, only about half of which are expected to be inseminated. However, in Portugal and Italy, hormones are very expensive, so the fixed costs of HF remain lower than those of HT.

Additional costs (annual cost of feeding bucks, melatonin and energy costs) are the lowest in Croatia (mainly because of the low costs of melatonin and electricity) and Portugal (mainly because of the low costs of feed and electricity) and highest in Romania (mainly because of the high cost of feed).

Total costs (fixed + additional costs) are higher under the three new protocols than the control HT protocol during both the breeding and non-breeding seasons. The HF protocol remains the most expensive, and PG2 is cheaper than PG1. The breeding season is less favourable than the seasonal anoestrus when applying the PG1 and HF protocols, which have to be combined with the new photoperiodic protocol based on continuous alternation of 90 long and 90 short days (which is very expensive in melatonin and electricity costs).

During interviews, technicians and breeders highlighted some important benefits associated with the FLOCK REPROD protocols, such as reducing the detrimental environmental impact, producing healthier goat products and generating advances in knowledge about goat reproduction. These important benefits are clear and known by the SME technicians, RTD researchers and organic breeders. However, significant constraints linked to the new protocols related to the more expensive and time-consuming procedures and the high variability of technical results. Despite this, results of the FLOCK REPROD project provide sustainable alternative solutions for reducing or excluding the use of hormones in AI. Some of them (the HF protocol and photoperiodic protocols without melatonin) represent the only hormone-free option for organic farmers performing AI during the breeding and non-breeding seasons. Further studies will be needed to simplify the male effect protocol, reduce costs and improve technical results to motivate the farming community to implement more environmentally friendly protocols.

APPLYING PROTOCOLS FOR HORMONE-FREE AI BASED ON USE OF THE MALE EFFECT FOR INDUCING AND SYNCHRONIZING OVULATIONS OUT OF THE BREEDING SEASON IN CARPATHIAN GOATS

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Abstract

The main objective of this study was to master use of the male effect combined with light treatment as a means of inducing synchronous ovulation in dairy goats for optimal efficiency of artificial insemination (AI) outside the natural reproduction season.

The experiment started in mid-February on two farms with 50 goats of the Carpathian breed per farm. All the goats were submitted to photoperiod conditions with 90 long days (LDs) and 60 short days (SDs) (using melatonin implants). To obtain the male effect, the female goats were isolated from the males at the beginning of the SD cycle. The males were introduced after 60 days of SDs (day 0 of the experiment), with aprons; apron markers were introduced on day 5. Oestrus detection was performed twice a day from day 5 to determine the moment at which 50 percent of the goats were marked. Half of the marked goats were inseminated 12 hours after positive detection, and the

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rest after 24 hours. Forty-five days after insemination, all the goats were examined by ultrasonography for pregnancy diagnosis. The occurrence of oestrus was 64 percent (32/50) on both farms. The pregnancy rates were 80 percent (21/30) for goats inseminated after 12 hours and 89.28 percent (25/28) for those inseminated after 24 hours. Mean prolificacy was 150 percent (69/46): 147.61 percent in the 12-hour group, and 152 percent in the 24-hour group.

Keywords: male effect, photoperiod, oestrus, artificial insemination

Introduction

The male effect is a technique for the natural control of reproduction in goats that is known to induce relatively synchronized ovulation and oestrus during seasonal anoestrus. It does not require recourse to hormones when using artificial insemination (AI) (Martin et al., 2004) for the genetic improvement of breeding schemes. The male effect, which is naturally present in goats, has been reported extensively since the first paper on this topic was published in 1944 (Rosa and Bryant, 2002; Martin et al., 2004). The presence of a male creates olfactory, behavioural and visual stimuli, which result in an increase in the secretion of the luteinizing hormone that stimulates folliculogenesis and ovulation in female goats (Radostits, Leslie and Fetrow, 1993).

Goats that are seasonal breeders can respond to the male effect in the deep anoestrus period if the male that is introduced is "in season". This effect in the male can be simulated with day-length manipulation combined with melatonin treatment. Validated protocols for hormone-free AI are based on applying the male effect after photoperiodic treatment (Delgadillo et al., 2009).

The main objective of this study was to master use of the male effect combined with light treatment as a means of inducing synchronous ovulation in dairy goats for optimal efficiency of AI out of the natural reproduction season.

Materials and method

Location and animals

The study started in mid-February 2013 on two farms in Romania owned by private breeders of Carpathian goats. The animals studied were two to four years of age and weighed 45–50 kg.

For each farm (75 goats/farm), the goats were divided into two groups: one for the experiment, and the other for control (with hormonal treatment):

a. The 50 goats in group A were hormone-free (HF) and submitted to the male effect (n = 10) with no hormonal treatment.

b. The 25 goats in group B were hormone-treated (HT) with fluorogestone acetate (FGA) sponges (Chronogest, Intervet, France, 20 mg FGA) associated with injection of 400 UI of pregnant mate's serum gonadotrophin (PMSG) (Folligon 1000 UI, MDS, Netherlands) and Reglandin (0.75µg of cloprostenol/goat).

Protocols applied

For HF protocols all the goats were maintained in photoperiod conditions for 90 long days (LDs) and 60 short days (SDs) with melatonin implants. The melatonin implant MELOVINE® was administered with an implant gun behind the ear. Recommended doses are one implant per female and three implants per male. Implants are effective for the 60 days of treatment.

For the male effect treatment in group A, the female goats were isolated from the males for 60 days before herd managers started the process for increasing the ovulation rate and shortening the breeding season. The introduction of males to the female herd elicits this response.

The groups of goats were prepared for 30 days before the experiment started. All the goats on each farm were examined for signs of pseudopregnancy 19 days before starting the experiment.

The males were introduced on day 0 of the experiment, with aprons; on day 5, apron markers were introduced. The optimal ratio is one buck per ten does, with daily rotation of the bucks to maintain optimal stimulation of the females. Contact between males and females was unrestricted, and bucks were placed with the females 24 hours a day continuously until AI.

Oestrus detection was performed twice a day from day 5 to determine the moment at which 50 percent of the female goats were marked and in oestrus. Half of the marked goats were inseminated 12 hours after this moment of "positive detection", and the rest, 24 hours after.

For AI, refrigerated sperm with progressive motility and viability of more than 75 percent was used. The quality of the sperm was determined by flow cytometric and microscopic methods. Refrigerated sperm was maintained at 4 °C and used within two to three hours of collection. The sperm dose for each AI was 0.20 ml with a concentration of 400 x 106 spermatozoa per dose.

All the goats in group B received FGA sponges on day 0 and injections of Folligon (PMSG 400 UI) and Reglandin (cloprostenol 0.75µg/goat) on day 9. The sponges were removed from the goats on day 11. Forty-three hours after removal of the sponges, all the goats were artificially inseminated with refrigerated sperm. Bucks were reintroduced for natural mating 21 days after oestrus, and ultrasonography was carried out 45 days after insemination.

For all the goats in the experiment, the following parameters were recorded: percentage of oestrus detected, percentage of goats returning to oestrus, fertility and prolificacy.

Statistical methods

Parameters were calculated using SPSS 17 software.

Results and discussion

The male effect refers to the effect of introducing males during the oestrus cycle of seasonally anoestrus females. It is a neuro-hormonal response that is elicited in the female herd.

However, its application on farms is not possible unless sufficient numbers of female goats are ovulating at the same time; goats in seasonal anoestrus respond variably to the male effect. Thus, two elements must be considered in the control of reproduction: the ability of females to reproduce out of season; and opportunities for synchronizing ovulation.

Under the hormone-free AI protocol, the bucks were introduced on 18 July 2013 (day 0). On day 5, twice-daily oestrus detection started. About half of the female goats (58/100) were detected in oestrus on day 7.5 (at 20:00 hours). Half of these goats (n = 29) were inseminated 12 hours later (at 08:00 hours on day 8) and the other half (n = 29) 24 hours later (at 20:00 hours).

Six goats were detected in oestrus on day 8 and were mated naturally.

In the HF group, the occurrence of oestrus in the goats was 64 percent (64/100), including the six detected on day 8; the return of oestrus was 23 percent (23/100). The overall pregnancy rate was 79.3 percent (46/58) for these goats: 70 percent (21/30) for those inseminated after 12 hours, and 89.28 percent (25/28) for those inseminated after 24 hours. Mean prolificacy was 150 percent (69/46): 147.61 percent for the 12-hour group, and 152 percent for the 24-hour group.

In goats treated with FGA sponges associated with PMSG treatment (Folligon), occurrence of oestrus was 86 percent (43/50) and return of oestrus was 4 percent (2/50). The pregnancy rate was 70 percent (35/50) and prolificacy 140 percent.

Table 1 shows the reproductive indicators of goats receiving HF or HT treatments on both farms.

TABLE 1. REPRODUCTION PARAMETERS OF GOATS ON FARMS 1 AND 2

Indicator	HF (%)	HT(%)
Occurrence of oestrus	64	86
Return of oestrus	23	4
Pregnancy rate	79.3	70
Prolificacy	150	140

In the HT group, all the goats were inseminated; in the HF group only those in oestrus by day 7.5 were inseminated.

Although the highest oestrus occurrence was recorded under the HT protocol (86 versus 64 percent), the pregnancy rate was higher under the HF protocol (79.3 versus 70 percent). However, the out of season HF application protocol has some inconveniences, as it requires the use of twice as many females and is known to be influenced by variations in female responsiveness and in the quality of the stimulus provided by the males. A major factor is the intensity of the animals' seasonality, as illustrated by the individual variations in responses to the male effect within breeds during seasonal anoestrus, and between breeds at different latitudes (Walkden-Brown, Martin and Restall, 1999). In addition, female responsiveness varies with a number of factors (Thimonier et al., 2000). The quality of the stimulus provided by the male can also be modulated by a number of factors, such as nutrition, the male/female ratio, the degree of contact between males and females, or recent sexual stimulation of the males (Chemineau, 1989; Walkden-Brown, Martin and Restall, 1999). New competitive HF strategies for synchronizing ovulations involve photoperiodic treatments (alternation of long and short days) (Malpaux et al., 1989) to induce sexual activity in males and females throughout seasonal anoestrus, as observed in HT in females (Chemineau et al., 1992).

The results of this study demonstrate that the male effect is a very promising non-pharmacological alternative to hormones for inducing and synchronizing oestrus during anoestrus in AI programmes that exclude the use of hormones, as also found in other studies (Restall, 1992).

Conclusions

The final HF protocol involves a single AI at a fixed time based on the occurrence of oestrus.

Under this protocol, 64 percent of the goats exposed to males will be inseminated, with a mean pregnancy rate of 79.3 percent, close to that obtained with the classical HT (70 percent). This protocol, based on the male effect without use of hormones, is satisfactory and of special interest for organic farms. Although the highest occurrence of oestrus was noticed under the HT protocol (86 versus 64 percent), the pregnancy rate was higher under the HF protocol (79.3 versus 70 percent). However, the out of season HF application protocol has some inconveniences, as it requires the use of twice as many females, with more males being introduced. In addition, synchronizing ovulations involves photoperiodic treatments to induce sexual activity in males and females throughout seasonal anoestrus.

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